This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at http://books.google.com/

LANE MEDICAL LIBRARY STANFORD
N227 .M41 1905 STOR
Conservative gynecology and electro-ther
24503351120

EX LIBRIS
DR. JAMES W. WARD

pain and blanched from hemorrhage, and then after their pain had been relieved and their bleeding had been stopped by galvanism and their cheeks had resumed a rosy hue: these fifty women's faces encourage me to do justice, though the heavens may fall, to the treatment which has cured them.

Then there pass before me the dying faces of *ten* women who were treated by total extirpation, at two of which operations I was the executioner: at six of which I was first or second assistant, and at two of which I was only a spectator.

True, the majority of the ten operations were performed in the preantiseptic days, though by a great master in this department of our art; but four of them were performed within the last few years under the most rigorous aseptic precautions by men who have a small mortality in general for abdominal surgery.

The memory of these fifty women who have been cured by electricity, many of whom I could find, if required, and many of whom to this day stop me in the street to thank me and it for their rosy cheeks: and the memory of those ten women who are now no more, all tell me that I would be a traitor to the cause of truth if I remained silent, not only out of season, but in the very hour when it most needed to be spoken.

True, I can quiet my conscience when circumstances compel me to operate, by the reflection that one woman died while under electric treatment, not through electricity, but through an error of diagnosis, for mistaking a tense, impacted, liquid tumor for a fibroid, which would not have been made if the abdomen had been opened, or, in other words, if the treatment had been surgical instead of electric. This is the one and only case in which, as far as my experience goes, I have ever had seriously to regret the use of electricity.

I can still further soothe my conscience when I am compelled to operate, by remembering that I have operated on ten women, seven by abdominal hysterectomy, treating the stump by leaving it transfixed at the lower angle of the incision; and on three by removal of the appendages, tying the ovarian arteries low down; and several others treated in the latter manner, at which I was assistant, all of whom rec [illegible] nd are now in good health.

When I visit the City [illegible] Love, where the surgeons have declared war to the knife [illegible] en placed in an awkward predicament. Wher [illegible] ce, that I am going to spend a few hours [illegible] surprised that a man of my intellig [illegible] ling nonsense, and it is useless f [illegible] y women in Canada, from Mani [illegible] t, who are pictures of health, [illegible]

On the other h [illegible] n go [illegible] to spend the mornin [illegible] lo [illegible] ng with pity on my bloo [illegible] oks life is too short to tr [illegible] him

In this somewha [illegible] tion, and that is, or, [illegible] which I shall presently lay before you are those of one who is entirely unbiased and nonpartisan, and are consequently to be accepted, as far as they go, in good faith.

My own opinion on the present status of electricity in the treatment of fibroids is fully made up, and I shall now endeavor to lay it plainly and honestly before you.

During the last year especially, although it has been growing gradually for several years, the conclusion has become evident that electricity is not suitable for every kind of case nor for every kind of doctor.

But it is as true to-day, as it ever was, that, for the cure of pain in and bleeding from the uterus, the application of the positive pole of the galvanic current, properly applied and of sufficient strength, to the uterine mucous membrane is, in the majority of cases, effective. The percentage of successes is greatest in those cases in which the fibroid growth is interstitial; not quite so great in the cases of submucous growths, although in several of these cases a few applications have been followed by the expulsion of the tumor from the uterine cavity. The earlier the cases come under treatment, the more surely they are cured, many patients with small interstitial tumors in the anterior wall having been completely cured by me, and still more under the care of others; so that the plea for the early treatment of fibroid tumors by electricity is quite as just a one as is the early plea for operative treatment. Indeed, it is even more so, for, while we can truthfully say that the electric treatment, when undertaken early and with a correct diagnosis, is at the present day entirely devoid of danger, no one can truthfully say the same of the treatment by operation. In fact, I am sorry to say that no one knows what is the death-rate of the latter treatment. Three of the ten deaths which I have above mentioned have never been reported, and six of them were only reported at my urgent solicitation.

May there not be many other similar cases? When a woman comes to a doctor for menorrhagia and he discovers a small fibroid, is he to urge her to submit to an operation, when he knows with the greatest skill and care she runs the risk of dying from the operation, and, if let alone, the death-rate is no more than 1 per cent., while with electric treatment the risk is absolutely nothing?

When she tells me that she will not submit to an operation, shall I assure her that I can do nothing for her, when I carry in my pocket the record of fifty similar or worse cases which have been cured by electricity? Surely that were dishonest! And yet the temptation to operate, in spite of the danger of surgical and the safety of electric treatment, is very great,—too great, in some cases, for us to resist.

Ours is a busy life, and there is not one of us here who has not often felt that life was far too short to accomplish all the good that we would wish to do, and, for the want of a few more hours in the day, much work of value to our fellow-beings must go undone. With this feeling strong within us, a poor woman applies at the out-patient department of our hospital with a small interstitial fibroid which has, however, doubled or trebled the bleeding

EX LIBRIS
DR. JAMES W. WARD

CONSERVATIVE GYNECOLOGY

AND

ELECTRO-THERAPEUTICS

A Practical Treatise on the Diseases of Women and Their Treatment by Electricity

BY

G. BETTON MASSEY, M.D.

Attending Surgeon to the American Oncologic Hospital, Philadelphia; Fellow and Ex-President
of the American Electro-Therapeutic Association; Member of the Société Française
d'Électrothérapie, American Medical Association, etc.

FOURTH EDITION
REVISED, REWRITTEN, AND GREATLY ENLARGED

**Illustrated with Twelve (12) Original, Full-Page, Chromo-lithographic Plates
and Twelve (12) Full-page Half-tone Plates of Photographs taken
from Nature, and Numerous Engravings in the Text**

PHILADELPHIA
F. A. DAVIS COMPANY, Publishers
1905

COPYRIGHT (First Edition), 1889
COPYRIGHT (Second Edition), 1890
COPYRIGHT (Third Edition), 1896
COPYRIGHT (Fourth Edition), March, 1905
BY
F. A. DAVIS COMPANY.

[Registered at Stationers' Hall, London, Eng.]

Philadelphia, Pa., U. S. A.:
The Medical Bulletin Printing-house,
1914-16 Cherry Street.

MT1
1905

PREFACE TO FOURTH EDITION.

Called upon for a fourth time to revise this work, the author has necessarily permitted the former edition to remain long out of print while endeavoring to bring up to date the practical subjects embraced within it. The progress of electro-therapeutics in general since the appearance of the last edition has been very great, and this has necessitated a complete re-writing of the more technical portions of the book, particularly that referring to the constant current and the theories and practical application of electrolysis and phoresis. Four entirely new chapters on the treatment of cancer by electro-chemical destruction and sterilization have been added, and it is hoped that these will be specially interesting to the large number of physicians now engaged in the treatment of this affection by Roentgen rays; while the important position attained by the latter is recognized by a complete though brief dissertation on Roentgen rays in diagnosis and treatment, prepared by Dr. Herman Grad, of New York, a well-known and able writer in this field.

The portions of the work relating to the Apostoli treatment, and to the author's methods for averting unnecessary sacrifice of the pelvic organs of woman by the use of electric modalities, have required but little change, save the further elaboration and corrections derived from additional experience. These questions have passed largely from the controversial stage into that of acceptance and action. The former opponents of this form of conservative gynecology have illustrated their purely surgical leanings, it is true, by transferring their attention to the surgery of the kidney and upper abdomen in the medical arena; but, meantime, a numerous class of physicians throughout the world have essayed to meet the problems of true gynecology presented to them in their offices and daily visits with added power because of a knowledge of electro-therapeutics. To

63365

this growing body of physicians the author primarily submits thi work, and to them is entrusted the truths, so important to humanity that have been bequeathed to us by Apostoli and Keith.

The author begs to acknowledge, with thanks, much practical assistance from his colleagues on the staff of the American Oncologi Hospital; and also tenders his thanks to Dr. Grad for his valuabl contribution. His thanks are also tendered to Mr. H. L. March fo the preparation of a number of additional drawings and diagram appearing in this edition.

1831 Chestnut St., Philadelphia.

PREFACE TO THIRD EDITION.

THE exhaustion of the second edition of the author's work on "Electricity in the Diseases of Women" necessitated the preparation of a third edition some time since. In preparing the material for this purpose it was found desirable to rewrite and restate so many of the facts connected with the application of electricity to the diseases of women, in order that the very latest advances in this subject might be adequately represented, that an entirely new book was the result, dealing more fully than heretofore with the nature and causation of the diseases of women in which electricity is urged as a rational remedy, as well as discussing in full detail the many minor points which are essential to success in its employment.

What was originally a mere treatise on the use of electricity in fibroid tumors and certain other affections has thus been transformed into a treatise on the medical and surgical diseases of women, with special reference to the therapeutic use of electricity. This broadening of the scope of the work has been made necessary by the fact that nearly all of the modern treatises on gynecology have been written from a purely surgical stand point, leading often to a perspective view of these affections that unduly exaggerated the mechanical side of pelvic pathology. Opportunity is thus afforded for the rescue from oblivion of certain neglected facts as to the origin and nature of inflammatory diseases of the uterus and adnexa, and for the fuller consideration of the neural disorders most frequently found among women, while special attention is accorded to fibroid tumors and their treatment by the Apostoli method, and to the author's method for the treatment of cancer.

As a treatise on the diseases of women no claim is made that it covers the field so ably occupied by the works on abdominal and pelvic surgery alluded to, but only that it covers ground of more value to the average physician and his patients than books devoted to the details of operations that, however necessary at times, are often only properly of service as last resorts, and are then incapable of application except at hands that have had more than a book-training. Besides, in the present redundant condition of the physician's book-shelves, no author has a right to burden his readers with attempts at comprehensiveness which transcend the immediate bounds of his personal experience, and when he confines himself to that experience and its teachings he has fully discharged his duty both to his readers and to science, without implying that the experience of others is not also of value.

With all modesty, therefore, but with a lively appreciation of the importance of the facts and methods herein detailed in enabling the progressive physician to save his patients from the dangers of both neglect and of misapplied methods of treatment, the author commends this work to his professional brethren and bespeaks for it a share of attention and kind consideration at least as great as that accorded to each of its predecessors.

Thanks are due to Mr. Xanthus Smith, the well-known artist, for the accuracy of the illustrations that appear here for the first time.

Instead of reproducing the new classical drawings of the motor points of the nerves and muscles, it was thought best to secure greater accuracy by verifying each point on the person of a professional model and then photographing the living subject. Plates VIII and IX are, therefore, half-tone reproductions of actual photographs, and it is hoped that this method of depicting the real situation of these points will lead to greater ease in their location than has been the case in the past. The services of a professional model were also invoked in the more realistic delineation of the therapeutic procedures shown in Plates III to VII.

In preparing the series of colored plates showing the appearance of the cervix and uterine discharges in typical cases of disease, in which Mr. Smith was engaged in pioneer work in medical illustration, special thanks are due to Drs. J. Montgomery Baldy, W. A. Newman Dorland, Frank W. Talley, Theodore A. Erck, Oliver Hopkinson, and Carrie Chase Davis for facilities afforded in securing the typical cases from which sketches were made.

June, 1898.

CONTENTS.

PART I.

CHAPTER I.

PAGE

THE NATURE AND THE PREDISPOSING CAUSES OF THE MORE COMMON AFFECTIONS OF WOMAN, ... 1

Developmental Faults of Early Womanhood. Disorders of Maturer Womanhood.

CHAPTER II.

ON THE EXAMINATION OF PATIENTS WITH REFERENCE TO THE PROPRIETY OF EMPLOYING CONSERVATIVE METHODS OF TREATMENT, . . 9

General Examination and Classification of Patients. Examination of the Abdomen. Examination of the Pelvis. Illumination of the Vagina. Transillumination of the Pelvis. Aspiration. Aseptic Precautions in Routine Gynecic Practice and Electrogynecology.

CHAPTER III.

INTRODUCTORY REMARKS ON ELECTRICITY AS A REMEDY IN GYNECOLOGY, 31

How Electricity Becomes a Remedy. Special Value of Electricity in Gynecology. Special Value of Electro-gynecic Applications to the General Practitioner. Limitations.

CHAPTER IV.

PHENOMENA ATTENDING THE TRANSMISSION OF CONSTANT CURRENTS THROUGH LIVING ORGANS, ... 38

Physical Reasons for Electrode Coverings. Current-diffusion Within the Body. Current-concentration. Polar Regions. The Interpolar Region. Electrolysis: Chemic Effects at Each Pole. Extent of the Destruction at the Poles. Phoresis: Cataphoresis. Anaphoresis. General Medicamental Phoresis. Phoretic Speed of Ions. Temperature Effects. General Physiologic Action of Constant Currents: Functional Stimulation and Sedation due to Polarization. Bactericidal Action of Electricity. The Alterative Action of Electricity. Indications for Choice of Poles. Interrupted Direct Currents in Gynecology. Differences Between the Currents Used in Medicine.

CHAPTER V.

TYPICAL METHODS OF APPLYING ELECTRIC CURRENTS IN THE DISEASES OF WOMEN, ... 64

General Direct Current Stimulation. General Induction Current Stimulation. Abdomino-dorsal Applications. Spinal Applications. Vaginal Constant Current Applications. Vaginal Induction Current Applications. Intra-uterine Constant Current Applications. Intra-uterine Induction Applications.

CHAPTER VI.

PAGE

ADDITIONAL SYSTEMATIC METHODS IN GYNECIC PRACTICE, ... 79

Posture. Hydrothermal Applications to the Pelvis. Vaginal Swabbing. Tampons. Pessaries. Massage.

CHAPTER VII.

THE BORDER-LINE BETWEEN NEUROLOGY AND GYNECOLOGY, ... 84

Differential Diagnosis between Hysteria and Neurasthenia. The Rest Cure in the Treatment of Hysteria and Hysteroid Affections.

CHAPTER VIII.

NEURASTHENIA AND NERVOUS PROSTRATION, ... 91

CHAPTER IX.

MENSTRUAL DERANGEMENTS, ... 96

Amenorrhea. Scanty Menstruation. Menorrhalgia. Menorrhagia and Metrorrhagia.

CHAPTER X.

CATARRHAL AFFECTIONS OF THE UTERO-TUBAL MUCOUS TRACT AND THEIR CONSEQUENCES, ... 110

The Etiologic Unity of Uterine and Tubal Catarrh. Diagnostic Value of Inspection of Persistent Uterine Discharges. Endometritis: Cervical Endometritis. Corporeal Endometritis. Chronic Inflammation of the Uterus without Extension to the Tubes and Ovaries: Chronic Metritis. Postpuerperal Metritis; Neglected Subinvolution. Hemorrhagic Metritis. Hyperplasia of the Uterus, With or Without Cervical Laceration. Senile or Atrophic Metritis. Chronic Inflammation of the Uterus with Extension to the Tubes and Ovaries: Metrosalpingitis. Purulent Salpingitis (Pyosalpinx). Discussion: Hematosalpinx. Hydrosalpinx. Pelvic Peritonitis.

CHAPTER XI.

CHRONIC INFLAMMATORY AFFECTIONS OF THE OVARIES, ... 138

Chronic Ovaritis. Ovarian Congestion. Postoperative Traumas and Neuroses.

CHAPTER XII.

FIBROID TUMORS, ... 146

Origin. Clinical Varieties. Natural Prognosis of Fibroid Tumors Without Treatment. Apostoli's Discovery. Mode of Action of Electricity. Selection of Suitable Cases. Contra-indications. Methods. Results of Treatment by Electricity.

CHAPTER XIII.

BENIGN TUMORS OF THE BREAST, ... 202

Areolar Hyperplasia of the Mammary Gland. Cystic Disease of the Mammary Gland.

CHAPTER XIV.

PAGE

THE TREATMENT OF CANCER BY CATAPHORIC STERILIZATION—THE AUTHOR'S METHOD, ... 205

The Author's Method. The Major Application. Source of Current. Controlling Apparatus. Dispersing Electrode. Active Electrodes. Essential Accessories. Details of Operation. The Minor Application: Choice Between Major and Minor Applications.

CHAPTER XV.

THE CATAPHORIC DESTRUCTION AND STERILIZATION OF MAMMARY AND AXILLARY CANCER, ... 225

Technical Details. After-treatment. Selection of Cases and Method. Major Application of Bipolar Cataphoresis.

CHAPTER XVI.

THE CATAPHORIC DESTRUCTION AND STERILIZATION OF UTERINE CANCER, 239

Cancer of the Cervix. Cancer of the Body of the Uterus.

CHAPTER XVII.

THE CATAPHORIC DESTRUCTION AND STERILIZATION OF RECTAL CANCER, 245

Details of the Major Application in Cancer of the Ano-rectal Region. After-treatment.

CHAPTER XVIII.

DISPLACEMENTS AND NONTRAUMATIC RELAXATIONS OF THE PELVIC VISCERA, ... 260

Electric Treatment: The Author's Method. Tripier's Method.

CHAPTER XIX.

RELAXATION AND FUNCTIONAL INCAPACITY OF THE ABDOMINAL WALLS AND VISCERA, ... 270

Indications for Massage of the Abdomen. Contra-indications for Massage of the Abdomen.

CHAPTER XX.

MATERNAL STERILITY AND IMPOTENCE, ... 274

CHAPTER XXI.

ECTOPIC GESTATION AND OBSTETRICS, ... 277

Ectopic Gestation. Abortion. Hyperemesis Gravidarum. Use of the Induction Current in Labor. Inertia Uteri. Postpartum Hemorrhage. Recent Subinvolution.

CHAPTER XXII.

BENIGN AFFECTIONS OF THE URETHRA, BLADDER, RECTUM, AND SIGMOID FLEXURE, ... 292

Diseases of the Urethra and Bladder. Caruncle. Stricture or Ulcerations of the Urethra. Neuroses of the Urethra and Vulva. Atony

PAGE

of the Bladder. Cystoscopy. Diseases of the Rectum and Sigmoid Flexure: Anal Fissure. Hemorrhoids. Prolapse of the Rectum. Stricture of the Rectum. Ulcerations and Adenoids of the Rectum.

CHAPTER XXIII.

THE COSMETIC APPLICATIONS OF ELECTRICITY, ... 307

Superfluous Hair. Moles and Warts. Nævus Valculosus (Port-wine Mark). Nævus Pigmentosus.

CHAPTER XXIV.

INSTITUTIONAL TREATMENT, ... 312

PART II.—RUDIMENTS OF MEDICAL ELECTRICITY.

CHAPTER XXV.

PHYSICS OF THE CONSTANT, OR DIRECT, CURRENT, ... 315

Electromotive Force (Pressure). Resistance. Units of Current. Internal Resistance of Cells and Batteries. Application of Ohm's Law to the Arrangement of Cells.

CHAPTER XXVI.

THE PRODUCTION AND CONTROL OF CONSTANT CURRENTS, . . . 328

Sources of Current: The 110-Volt Direct-Current Street Mains. The Current Controller. The Meter. Wall Plates and Cabinet Apparatus. Stationary Battery of Cells. Portable Batteries. Electrodes.

CHAPTER XXVII.

EXPERIMENTAL HANDLING OF CONSTANT CURRENTS, ... 351

To Test for Current (Experiment 2). To Test the Power of the Battery and the Range of the Controller (Experiment 3). To Test the Polarity of the Electrodes (Experiment 4). Comparison of Metallic Contact with Moist Cotton to Cotton Conduction (Experiment 5). Application of Dry Metallic Electrodes to Skin Compared with that of Wet Electrodes (Experiment 6). Effect Produced on the Current-volume by Salt Water on the Electrodes (Experiment 7). Effect upon the Current of Different-sized Electrodes (Experiment 8). Comparison of the Effect of the Same Current-strength when Concentrated and Diffused (Experiment 9). Differing Resistances of Skin Surfaces (Experiment 10). Comparison of the Resistance of Skin and Mucous Membrane (Experiment 11). Alteration of Nerve Irritability Within each Polar Region (Experiment 12). The Effect on Nerves of a Slowly Varied or Continuous Current Compared with that of a Sudden Current Variation (Experiment 13). To Locate Faults in the Circuit.

CHAPTER XXVIII.

PAGE

The Magnetic Induction Current, ... 358

Mode in which Magnetic Induction Currents are Produced. Means of Controlling Induction Currents. The Cell and Cell-Current. The Primary Coil and Core. Primary Current. The Interrupter, or Rheotome. Combined Constant and Induction Currents. Polarity of the Induction Current. Indications for the Use of Covered and Bare Electrodes with Induction Currents. Experimental Comparison of the Electromotive Force, or "Pressure," of the Induction Current with that of the Constant Current (Experiment 14). Action of the Induction Current on Sensory Nerves and Muscles. Therapeutic Uses. Electrodes and Dosage.

CHAPTER XXIX.

Static Electricity, ... 373

Physics. Selection and Care of the Static Machine. "Ground" Connections. Precautionary Hints. Methods of Application. Ozone Administration. After Using the Machine. Therapeutic Uses in Gynecology.

CHAPTER XXX.

The Sinusoidal and Incandescent Alternating Currents, . . . 387

The Sinusoidal Current. The Incandescent Alternating Current.

CHAPTER XXXI.

Roentgen Rays in Diagnosis and Therapeutics, ... 394

Introductory: Static Machine. Induction Coil. Interrupter. Fluoroscope. Radiographic Plate. Stand. Trays. Lamp. Tube. Nature of the Roentgen Ray. Fluoroscopy. Skiagraphy. Radiotherapy: X-ray Dermatitis.

APPENDIX.

Table of One Hundred and Ten Consecutive Cases of Fibromata, with Details of Treatment and Ultimate Results, . . . 437

Index, ... 461

LIST OF ILLUSTRATIONS.

FIG. PAGE
1. Dorsal position. (Drawn from photograph of model.) 13
2. Diagram of abdominal regions, showing position of viscera. (After Gray.) 14
3. Bimanual abdominal palpation. (Drawn from model.) 15
4. Abdominal relaxation, as shown in the erect position 16
5. Goodell bivalve speculum, latest pattern 17
6. Various styles of silvered and bare glass, porcelain, and hard rubber tubular specula 18
7. Bimanual pelvic examination 19
8. Simpson's sound 20
9. Method of inserting sound by touch. The finger is shown behind the cervix 21
10. Sims's position. (From photograph of model.) 22
11. Sims's speculum 22
12. Attitude of nurse in Sims's position. (Drawn from photograph of model.) 23
13. Miniature diagnostic lamp mounted on aseptic glass tube holder 24
14. The Meyrowitz volt-controller for diagnostic lamps 25
15. Alternating current "step-down" transformer 26
16. Portable dry cell battery for six-volt miniature diagnostic lamp, containing four dry cells, with controller 27
17. Pocket battery of dry cells for miniature diagnostic lamp 28
18. Author's pelvic transilluminator 28
19. Aspirator 29
20. Applying absorbent cotton to electrode disk (first stage) 39
21. Applying absorbent cotton to electrode disk (second stage) 39
22. Diagram showing the distribution of a current of 20 volts within a narrow conductor 41
23. Distribution of a current of 20 volts within a wider conductor 41
24. Distribution of a current of 20 volts within the human body 42
25. Diagram of polar and interpolar regions 44
26. Diagram of electrolysis 47
27. Apparatus employed by Apostoli for testing the bactericidal action of electricity. 60
28. The Massey vaginal electrode for mercuric cataphoresis 68
29. Goelet's bipolar vaginal electrode 70
30. Apostoli's intra-uterine electrode 71
31. Author's sound-shaped platinum intra-uterine electrode, with fusible covering of shellac 72
32. Author's spiral elastic intra-uterine electrode of platinum 73
33. Set of zinc intra-uterine electrodes for mercuric cataphoresis (sizes 5 to 11, French scale) 74
34. An excellent set of zinc-mercury intra-uterine electrodes 75
35. Apostoli bipolar intra-uterine electrode with fusible, aseptic covering 77
36. Knee-chest position. (Drawn from photograph of model.) 79
37. Section of uterus made at os internum. (Barnes.) 100
38. The author's monopolar vaginal electrode 132
39. Line of rigidity in pelvic peritonitis. (Thomas and Mundé.) 136
40. Intramural fibroid tumor. (Drawn from specimen in the Mütter Museum of the College of Physicians of Philadelphia.) 147
41. Submucous and intramural fibroid tumors. (Drawn from specimen in the Mütter Museum of the College of Physicians of Philadelphia.) 148

FIG. PAGE
42. Multinodular interstitial fibroid with submucous projections. (Drawn from specimen in the Mütter Museum of the College of Physicians of Philadelphia.) 149
43. Fibroid polypus 150
44. Subperitoneal fibroid with sessile attachment to posterior wall of uterus. (From specimen in the Mütter Museum of the College of Physicians of Philadelphia.) 151
45. Pedunculated subperitoneal fibroid. (From specimen in the Mütter Museum of the College of Physicians of Philadelphia.) 152
46. Multinuclear interstitial fibroid with one nodule affected by calcareous degeneration. (From specimen in the Mütter Museum of the College of Physicians of Philadelphia.) 153
47. Apostoli's vaginal puncture trocar, for use with handle shown in Fig. 30 160
48. Author's vaginal puncture trocar (enlarged sectional view) 161
49. Author's abdominal puncture needle (shown in enlarged section) 164
50. Diagram of original outline of tumor in Case 1 168
51. Diagram of original outline of tumor in Case 5 169
52. Diagram of original outline of Case 6 170
53. Diagram of original outline of Case 7 171
54. Diagram of original outline of Case 13 172
55. Diagram of original outline of Case 17 173
56. Original outline of tumor in Case 35 175
57. Outline of tumor in Case 35 after treatment 176
58. Original outline of tumor in Case 38 177
59. Outline of uterus in Case 38 after treatment 178
60. Outlines of tumor in Case 46 at various dates 179
61. Original outline of tumor in Case 61, showing method of treatment 182
62. Outline of Case 61 in 1896 183
63. Outline of tumor in Case 1 of Dr. Haultain's before treatment. (Haultain.) .. 194
64. Case 1 after treatment. (Haultain.) 195
65. Outline of tumor in Case 2 of Dr. Haultain's before treatment. (Haultain.) .. 196
66. Case 2 after treatment. (Haultain.) 197
67. Cataphoric destruction and sterilization of cancer of the breast 209
68. Author's portable dry-cell battery with lid raised, showing switchboard 210
69. Portable battery with switchboard raised, showing large Columbia dry cells 211
70. Arrangement of batteries and apparatus for major application of cataphoresis .. 213
71. Gold puncture electrodes with glass syringe for injecting mercury 217
72. Hollow bulbous gold electrode 218
73. Set of zinc-mercury electrodes for the cataphoric treatment of cancer 219
74. Case of Mrs. P. nine months after application, showing V-shaped linear cicatrix. 232
75. Case of Mrs. S. Photograph of growth, October 9, 1902, before application of cataphoresis 234
76. Case of Mrs. S. Appearance on October 10th, the day after application 234
77. Case of Mrs. S. Appearance of healing wound on December 3d, eight weeks after application 235
78. Case of Mrs. S. five months after application (photograph of March 30, 1903), showing healed wound except small spot due to imprisoned quicksilver 235
79. Case of Mrs. S. one year after application, showing healthy scar and restored general health. 236
80. Diagram of medium section of pelvis and sarcoma 253
81. The two pieces of devitalized sarcoma tissue and the segments of the coccyx, as they appeared after separation (reduced to one-fourth size) 254
82. Photograph of scar seven and one-half months after destruction of sarcoma of sacrum (full size) 255
83. Photograph of case of T. McD. Taken before second operation, showing large size of external growth at that time 257
84. Photograph of present condition of T. McD. Taken six months after that shown in Fig. 83 258

FIG. PAGE
85. Sectional view of a case of hypertrophy and prolapse of the infravaginal cervix. 265
86, 87, and 88. Tripler's rectal, uterine, and vesical electrodes for displacements.. 267
89. Tripler's induction current method for anteflexion.................................. 268
90. Tripler's method of induction current treatment for retroflexion.................. 269
91. Gaiffe's pocket induction battery.. 289
92. Cystoscope of J. Howard Kelly 296
93. Urethral calibrator 297
94. Kelly's urethral dilator 298
95. Cystoscopic syringe 299
96. Urethral searcher 300
97. Author's hemorrhoidal needle electrode (sectional view, showing appearance when coated with shellac) 304
98. Diagrammatic representation of the cause of flow in hydraulic currents........ 316
99. Diagrammatic representation of the cause of flow in electric currents.......... 317
100. Diagram of direction of current within a cell.. 318
101. Diagram showing analogy of laws governing pressure in pump and dynamo circuits 319
102. Diagram illustrating electric units by the water analogy. (From Hedley.)..... 322
103. Three cells connected "in series".. 323
104. Three cells connected "for surface," or in parallel arc............................ 324
105. Graphic delineation of the pressure and volumes of currents from a single voltaic cell when various resistances are inserted into the external circuit.. 325
106. Graphic delineation of the pressure and volumes of currents from a battery of 20 cells arranged "for surface.".. 326
107. Graphic delineation of the pressure and volumes of currents from a battery of 20 cells arranged "in series."... 327
108. Diagram of wiring of switchboard for medical use of 110-volt current from street mains 330
109. Vetter current tap, with connection for Westinghouse, Edison, or Thompson-Houston receptacle 331
110. Route of current in patient's circuit in Jewell graphite controller.............. 332
111. The Massey universal therapeutic controller.. 333
111*a*. Plan of wiring of universal therapeutic controller 334
112. Diagram of the several paths, or "shunts," of the circuit of the author's new universal controller 335
113. Weston milliammeter, arranged specially for medical work........................ 337
114. The author's arrangement of wall cabinet and universal controller, as manufactured by Frank S. Betz Co., Chicago... 339
115. Plan of wiring of switchboard for both constant and induction currents, with switch for combining both currents for simultaneous use...................... 340
116. Arrangement and proper plan of wiring of stationary battery of cells, with controller and meter in circuit... 341
117. Carbon cylinder cell 342
118. Carbon-zinc dry cell. 343
119. Author's portable dry-cell battery, with meter and controller in circuit.......... 346
120. Jacketed pan for clay pads... 348
121. Author's wired cotton electrode pads.. 349
122. Diagram of induction battery.. 359
123. Flemming's No. 4 induction battery, possesssing a high-tension coil and excellent primary, controlled by the du Bois-Reymond slide.................... 362
124. McIntosh induction battery 363
125. End view of Rockwell's high-tension coil, as made by the Jerome Kidder Manufacturing Company 364
126. Engelmann's induction battery 365
127. The de Watteville combiner, for simultaneous administration of constant and induction currents 368
128. Betz static machine, with twelve revolving plates.................................... 375

FIG. PAGE
129. Type of Waite & Bartlett machine 377
130. Static charge 379
131. Connections for positive spray 380
132. Indirect sparks 381
133. Direct sparks 381
134. Direct sparks with patient in shunt 382
135. Morton's wave current 382
136. Morton's static induced current 383
137. Diagram of transformer connections for high-frequency currents from static machine 383
138. Connections for vacuum tube currents 384
139. Some electrodes and the insulated platform used in static applications 385
140. The Kellogg sinusoidal apparatus 387
141. Graphic representation of the sinusoidal current of Dr. Kellogg's apparatus. (Kellogg.) 388
142. Sinusoidal curve obtained by d'Arsonval 388
143. Current from induction apparatus (McIntosh) 388
144. Current from induction apparatus (McIntosh) 388
145. Representation of magneto-electric current not sinusoidal in character. (Kellogg.) 389
146. Current from du Bois-Reymond coil 389
147. Characteristic marking of the rapidly successive inductions of a poor induction coil. (Kellogg.) 389
148. Current from coil excited by Thompson-Houston arc light, alternating 16,800 times per minute. (Kellogg.) 389
149. McIntosh sinusoidal apparatus, with motor 390
150. Kennelly sinusoidal apparatus and motor 391
151. Van Houten & Ten Broeck static machine 396
152. Roentgen ray coil 398
153. Electrolytic interrupter 399
154. Fluoroscope 400
155. X-ray stand with tube and plate holder 403
156. Roentgen ray tube with light anode, for static machine 405
157. Roentgen ray tube with heavy platinum anode, for coils 407

LIST OF FULL-PAGE PLATES.

PAGE
PLATE I.—Arrangement of examining chair and apparatus........Facing 64
PLATE II.—Arrangement of applying couch and apparatus........Facing 66
PLATE III.—Application to arm, general direct current stimulation. (Photographed from professional model.)......Facing 68
PLATE IV.—Application to leg, general direct current stimulation. (Photographed from professional model.)......Facing 70
PLATE V.—Application to abdomen, general direct current stimulation. (Photographed from professional model.)......Facing 72
PLATE VI.—Stabile induced current application to abdomen, general direct current stimulation. (Photographed from professional model.)............................Facing 74
PLATE VII.—Dorso-abdominal application, general direct current stimulation. (Photographed from professional model.) Facing 76
PLATE VIII.—Motor points of anterior portion of body. (Photographed from professional model.).....................Facing 78
PLATE IX.—Motor points of posterior portion of body. (Photographed from professional model.)....................Facing 80
PLATE X.—Chronic leucorrhea of vaginal origin (colored)........Facing 112
PLATE XI.—Chronic purulent leucorrhea of uterine origin (colored) Facing 114
PLATE XII.—Erosion of cervix with slight laceration (colored)...Facing 116
PLATE VIII.—Erosin of cervix (colored)........................Facing 118
PLATE XIV.—Cervical endometritis (early stage) (colored).....Facing 120
PLATE XV.—Cervical endometritis (late stage) (colored).......Facing 122
PLATE XVI.—Gonorrheal endometritis (early stage) (colored).. Facing 124
PLATE VII.—Corporeal endometritis of septic origin (colored)..Facing 126
PLATE XVIII.—Purulent leucorrhea in metrosalpingitis of gonorrheal origin (colored)............................Facing 128
PLATE XIX.—Traumatic relaxation of the pelvic outlet with cystocele and rectocele (colored).......................Facing 262
PLATE XX.—Hypertrophy and prolapse of the infravaginal cervix in a young negress (colored).....................Facing 264
PLATE XXI.—Carcinoma of the cervix uteri (colored)..........Facing 266
PLATE XXII.—Author's wall cabinet............................Facing 338
PLATE XXIII.—Skiagraph in a case of fracture.................Facing 414
PLATE XXIV.—Skiagraph in a case of foreign body............Facing 418

PART I.

CHAPTER I.

THE NATURE AND THE PREDISPOSING CAUSES OF THE MORE COMMON AFFECTIONS OF WOMAN.

Developmental Faults of Early Womanhood.—The girl is the antetype of the woman in physical as well as mental endowment; hence the prophecy of a wholesome maturity, or the seeds of many of the physical and neural ills of womanhood, may be traced in the heredity received, plus the environment of her developmental stage. Under the unrestrained operation of the laws that govern evolution the all-pervasive influences of an awakening womanhood tend toward the more perfect establishment of its character in the individual, and would doubtless, in later generations, produce women of increasing womanliness, physically and mentally for natural selection between the sexes is apt to be governed by inherently correct mutual attractions. The conditions of civilization and the demands of society, however, do much to nullify rather than increase such wholesome tendencies, and the result of marriages as usually contracted is often the production of stationary or atavistic progeny.

Under the operation of unwise or accidental sexual selection we may have, therefore, the descent of an acquired heredity of physical weakness or emotional impressionability,—conditions which, if associated with noncorrective environment, are sure to result in disaster to the life-history of the individual. In heredity we have, consequently, a most potent cause for the developmental faults of early womanhood.

The influence of environment either in perfection or correction of girlish character is peculiarly powerful in her stage of development, for, contrasted with that of man, this stage of development involves phenomena of a far greater relative importance, the physical and mental phenomena that bear a direct relation to sexual characteristics impressing every fiber of her being, her emotions, and her judgment. Nature has, herself, therefore, made the hygienic path of girls narrower than that of boys, for, in endowing them with the susceptibilities of highly specialized functions, it has furnished another predisposing cause for disease, in the shape of a special vulnerability to unfavorable environment.

Since heredity is beyond the control of living beings (and society even yet refuses to apply well-known rules of scientific breeding to its unborn children), it is to the correction of environment that both parents and physicians must look for reparative effects, and it is fortunate that environment may be, at times, as effective in producing results as heredity itself.

In the scientifically bad environment we have the second, but most practically important, cause of developmental faults in young girls. Striking portions of this are: influences which cultivate selfishness and neglect inculcation of that wholesome instinct of self-sacrifice in little matters which does so much to ennoble womanly character; influences which favor introspection as to bodily ills and cause undue attention to be paid to little aches and pains that would be forgotten were more attention paid to active duties and pleasures; lack of earnest occupation for body and mind; lack of outdoor life; mental cramming, with neglect of physical education in schools; neglected excretions; unhygienic dress.

It is well known that hysteria is rarely or never found except in girls who have, at some time, suffered from that unfortunate mental failing known as "spoiling"; but it is not so well appreciated that its earliest evidences may be traced to the habit of selfishness and self-indulgence in little things, and that this habit long fostered requires but little else to produce the disease. Of lack of mental occupation it may be remarked, in passing, that there are but two attitudes toward the problems of her immediate future that are mentally healthy for young girls: they must either cultivate society and a natural interest in the young members of the opposite sex among their acquaintances, or they must devote unflagging energies to some real pursuit or occupation. It is the more retiring and prudish girls who, while neglecting the career of a social favorite, and failing to replace its mind-absorbing duties and pleasures by an equally absorbing career or occupation, fall early victims to neurasthenia and other nervous troubles.

Some of the instances of bad environment enumerated are fortunately fast disappearing, but many of them are still most conspicuous and active enemies of womanly health and perfection. The hygienist of to-day has much to be thankful for in the changing conditions governing the lives of intelligent girls and women, thanks to the somewhat recent elevation of health and vigor into an idol of fashion. Protests are still made against waist-borne clothing, it is true; but much of this is hypercritical, for it cannot be easily demonstrated that the shoulders, suspended from the chest as they are by mere muscular and ligamentous attachments, are better adapted to support clothing than a bony prominence, such as the hip, which is superposed directly on the bony structures of the thigh and leg. The question is entirely apart from that of tight lacing, than which nothing could be more injurious to the organs of the abdomen and pelvis. That our grandmothers could have existed within their "stays" is but an evidence of physiologic endurance. Their granddaughters are more sensible; yet the physician, and the artist also, must still bewail a fashion that not only constricts the waist to an improper degree, with consequent displacement of internal organs, but destroys the vigor, pliancy, and independent activities of the abdominal and dorsal muscles, resulting in weak backs, weak abdomens, and notorious distortion of the abdominal contours. The most conservative advice a physician can give is that the wearing of even a tight waist should be postponed as late as possible in a young girl, reserving loosely fitting straight front corsets for mature women whose figures require them.

Besides inculcating the preventive measures naturally indicated by the mere suggestion of such and kindred faults of environment, the physician should not hesitate to welcome and advise the sensible use of the bicycle by young girls, under the important conditions of an anatomically correct saddle, an upright position on the wheel, and proper moderation in its use. With these conditions secured, one can be certain that a valuable hygienic measure has been attained which will not only prevent, but even cure, maldevelopment of the secondary puberty, when so many of the disorders of young womanhood arise. As for golf, tennis, skating, and other outdoor sports, too much cannot be said in praise of these agencies, which are doing so much to improve American womanhood.

Among the most serious maldevelopments of young girls is an imperfect evolution of the menstrual function, in which this evidence of maturity is attended with undue pain. This subject is fully considered in the appropriate chapter; but in this summary of the underlying causes of the affections peculiar to women it is proper to note that the author regards these conditions as strictly neural or inflammatory, or a combination of both, and that his experience has enforced the conclusion that the mechanical obstruction theory of menstrual pain is a widespread delusion and totally unsupported by the facts. No damming up has ever been observed in these cases, nor has it been proven that the narrow or tortuous uterine canal is not still capable of giving exit to the menstrual fluid supposed to be held back by it. Until actual obstruction can be proven it is evident that the elaborate operations of slitting up or dilating the cervix are illogical and harmful, the few instances in which it has apparently been of service in allaying pain being equally explainable on the theory of this effect being actually due to the cure of the hyperesthesia. It is evident, on the contrary, that the pain, as a rule, precedes the flow, and, in the absence of an expansion of the uterine cavity above the internal os, it is clear that it precedes the actual secretion of the fluid itself. Common sense alone would indicate, therefore, that undue menstrual pain is a reaction between vasomotor conditions within the affected organs and their nerve-centers, the remote causes being either a bad local or general nutrition and development, or consequences of catarrhal invasion. This view is, of course, not entirely new, and is even found in text-books that dictate methods of treatment entirely founded on discredited mechanical theories, but it needs the impetus of a vigorous propaganda to be brought home to the consciousness of gynecologists at large, and to dictate a less mechanical and more effective treatment and one more in accordance with the true nature of the condition.

But our concern here is more with the original causation of this affection, and this aspect of the question is the more important since it bears a direct relation to the possibility of preventing one of the most common complaints of young womanhood. Why should so many girls complain of these intense pains and cramps at the occurrence of a purely physiologic and normal cyclic point in their routine physical life? Varying amounts of discomfort and nervous erethism are probably natural, but this invalidism in health surely is not.

We have here heredity and environment again,—an heredity of neuropathic tendencies,—if combined with a neurotic environment being fully capable of furnishing a ready subject for the affection, which in its earlier stages can be none other than an intensification of the normal congestion of an imperfectly developed and imperfectly nourished apparatus. And we might also consider the environment of the pelvic organs themselves, when a habit of constipation causes them to be crowded and their blood-supply diminished and vitiated.

But two additional influences are now required to develop a merely neurotic functionation into one attended with pronounced menorrhspasm and menorrhalgia, the first step establishing the uterine form and the second the ovarian form of the disease: 1. If, coincident with this undue physiologic congestion the patient catches cold, with its microbic and neural causation, we have an endometritis, constituting the uterine form of menorrhalgia. 2. The second step is the upward extension of the catarrhal aggravation of normal congestion until the ovaries are affected, which is favored by additional exposure to cold, artificial stimulation of the sexual organs, the contraction of a marriage while still uncured, and, finally, it is to be said, with regret, that the operation of divulsion for the cure of uterine menorrhalgia is too frequently followed by an extension to the ovaries.

A few words may be said at this point of the intimate relation of clothing and "catching colds." The author is convinced that the wearing of heavy underclothing is always a serious mistake, and particularly that the wearing of wool next the skin is the most prolific cause of catarrhal diseases. Wool is not absorbent,—no one would dry a wet face with this material,—and one who wears it next to the skin is kept in a continuous moist bath, resulting in colds at the slightest exposure. It is also practically a second skin, and so protects the natural skin that the latter fails to perform its duties as a protective, such as are normally brought about by vasomotor changes in response to heat and cold, leaving the system a prey to the slightest weather changes. Its qualities are only of proper value as an outer covering.

Disorders of Maturer Womanhood.—With the regular establishment of the monthly cycle in her nature, woman has an ever-recurring test of her well-being, which is also, in a manner, a tax upon the associated functions of catabolism and anabolism, nutrition and waste, to which it is correlated through the sympathetic nervous system.

To this, in the connubial state, is added the full performance of a function which, normally conducted, adds distinctly to her well-being, but which is too often attended with a lack of common sense, prudence, and temperance that would put the so-called lower animals to the blush. Throwing aside instinct, which regulates so beautifully the connubial relations of these same lower animals, man has failed too often to replace it with proper intelligence and control, and the result is, at times, harmful to the general well-being of the individual. The effect of excess in frequency alone is often sufficient to deceive both patient and physician into the belief that a diseased condition exists. If to this be added an abnormal performance of the function with the intent to prevent conception we may have the pains and aches and weight sensations of actual disease, which, of course, baffle the physician and his remedies so long as the cause continues to be repeatedly invoked.

Little need be said, in this place, of the causative influences derived from the necessities and accidents of pregnancy and childbirth, as these are fully evident to any practitioner and are usually rather overstated than understated from the mechanical point of view. It is, indeed, a marvel how great are the changes involved in the evolution and involution of the maternal organs in this physiologic process, without residual change, and especially so when it is remembered that the evolution is so often interfered with by tight lacing in younger women. Involution is, nevertheless, so well conducted by nature under ordinary conditions that, unless interfered with, the parts are restored very nearly to their ante-impregnated condition in a surprisingly short time. Many cases of gynecic complaints arise, nevertheless, in interferences with this normal involution, the chief varieties of interference being either traumatism or infection.

Of traumatisms the most important is laceration of the cervix uteri, for the reason that the laceration permits an easy entrance to the germs of catarrhal inflammation, which is a most important concomitant of subinvolution of the uterus. It is nevertheless a mistake to confound the morbific effect of the laceration in this early stage with its relative importance in the later stages. The theory of Emmett as to the pathologic importance of healed tears of the cervix has been enormously overdone, particularly in this country, where the operation of trachelorrhaphy has been so frequently performed for either general nervous symptoms or actual disease of the uterus supposed to be due to it. The connection is clearly fanciful and has no analogy in similar causes of disease in any other part of the body. To get at its true value one should look carefully for cases of old lacerations and compare the symptoms of those in which the laceration alone exists, without concurrent chronic inflammation of the uterus, with those in which this condition is also associated. It will be found that the simple laceration is without symptoms, except the occurrence of early miscarriages when the tear has been deep. This clearly indicates that the chronic metritis is the true cause of the symptoms.

In catarrhal invasion of the uterine and tubal mucous tracts we have, indeed, the true cause of the great majority of the pelvic diseases of women as they present themselves to the active practitioner. Some of these are, of course, gonorrheal in origin,—the worst cases, in fact; but that very many are entirely free from any etiologic connection with the gonococcus has been most abundantly demonstrated. The germs of ordinary purulent inflammation are practically ubiquitous, and are ever ready to attack a mucous membrane in which the physiologic resistance has been reduced either by traumatism, functional abuse, or the peculiar and as yet poorly understood neural influences of "catching cold."

That nonspecific microbic invasion, with its sequential war of cells between the microbes and the phagocytes, is at the bottom of the great bulk of common pelvic diseases is as evident as that a similar catarrhal process is the principal pathologic condition in chronic nasal affections. There is also a further analogy between the most common conditions of the two mucous tracts in the readiness with which the catarrhal affection spreads upward by continuity of tissue, in the one case affecting the Fallopian tubes and ovaries and, in the other, the Eustachian and nasal tubes, the ear, and the eye. An important conclusion to be drawn is that the initial lesion in the uterus or nose should receive primary attention in any therapeutic effort. This is fully acted upon, I believe, by the ophthalmologists and otologists, and was formerly well understood in relation to the uterus, but the nature of the uterine therapeutics then in vogue—the application of caustics, etc., to the cervix or within the cavity—was of a character to frequently aggravate the upper extensions of the affection. It might justly be said, of these methods, that they were directed to the uterus rather than to the affection as a whole, with a proper inclusion of its original and still persistent seat in the uterus.

The recent surgical school, whose opportunities for actually seeing and handling diseased tubes and ovaries has justly brought this portion of the genital mucous tract into prominence, has somewhat naturally fallen into the opposite extreme of neglecting the residual affection of the uterus while paying all attention to the tubes and ovaries; and, when the mode of relief selected consists in simple removal of the latter organs, has been confronted with a continuance of the symptoms from the portion of the affected structures left behind.

Catarrhal disease of the utero-tubal tract is itself an entity and should be dealt with as a whole rather than in some of its parts. That it is totally lacking in malignancy, and ordinarily susceptible of a more curative treatment than that by a removal of some of the organs affected by it, is too evident to be insisted upon were not an opposite practice so common.

And it should be distinctly understood that if we eliminate uterine or more general pelvic inflammation with its results in interstitial hyperplasias with or without morbid adhesions, or, to state it more practically, if these conditions be cured, we need take no account of the exact position of the uterus except it be retroflexed to the second degree or prolapsed at least to the same degree. This organ is normally movable and capable of considerable deviation from its position at rest; hence fixation in the normal position is even worse than a movable displacement. While the badly displaced, yet movable, uterus will give symptoms due to the displacement itself, much of the discomfort is really due to the concurrent endometritis or hyperplasia, and though it is impracticable at times so to tone up the weakened supports as to enable them to regain their functions, we may at least relieve them of added labor by reducing the bulk of the uterus to normal. With this help a complete restoration may be ultimately gained without resorting to the temporary expedient of pessary wearing, which only adds to the atrophy of the natural supports.

CHAPTER II.

ON THE EXAMINATION OF PATIENTS WITH REFERENCE TO THE PROPRIETY OF EMPLOYING CONSERVATIVE METHODS OF TREATMENT.

It cannot be said that the physician who is skilled in the application of electricity and other conservative methods in gynecology has as great a moral responsibility for accurate diagnoses as the surgeon, for the cost in lost functions or lost lives of the surgeons' mistakes are out of all proportion to any consequences of the mistaken diagnosis of the former. Yet a responsibility for accuracy in diagnosis and treatment is inherently associated with all medical work, and in no department of therapeutic management is the importance of an accurate conception of the true nature of the disease of more value than in electro-gynecology, for in this work both the indications of treatment and the special technique of applications to different affections are unusually clear. There is, moreover a two-sided responsibility involved in the examination of cases with a view to the propriety of electric treatment, for, while desirous of making all possible applications of an art that is capable of restoring health in so many cases *without injury or loss of organs or risk to life,* the physician should not make the mistake of counseling the employment, or attempt to employ, this method in cases where the blessings of modern aseptic surgery are both *proper* and *expedient.* It is the abuse and not the proper use of surgical methods that should be avoided.

The electro-gynecologist should therefore be a trained specialist in the diseases of women, in its fullest sense, though his highest usefulness will be lessened by a simultaneous ambition to be a great abdominal surgeon, for the temptation to use his surgical skill in that most attractive field may curtail his employment of electricity, which, though at times slow in producing cures, may, even in these tardy cases, yield the most brilliant results as a reward of patient persistence.

In certain classes of cases a training in neurology is equally important, for it is a heresy of the age, leading, at times, to dire results, that regards the diseases of women as merely mechanical and surgical.

And that the electro-gynecologist should, first of all, be a physician, in the broad sense of the designation, fully alive to the constitutional, diathetic, assimilative, and eliminative conditions of his patient goes without saying, for it is self-evident that the true specialist is only he that adds something to the broadest training of the well-educated physician.

Last, but by no means least, he should be thoroughly familiar with the physics of electricity,—an elementary subject that should be mastered by the student, together with other natural sciences, before he is permitted to enter a medical college. In default of this previous training, or in case of decided rustiness, the reader is advised to turn at once to the second portion of this work, where will be found a complete elementary introduction to general electro-therapeutics.

General Examination and Classification of Patients.—When a patient presents herself with a self-evident affection, such as a large neoplasm, either benign or malignant, or other patent condition well understood by herself and her previous medical attendants, there is no difficulty in at once placing the case in a general class for further special study. If, on the contrary, the pain, tenderness, weakness, or other subjective complaints point to merely an abnormal condition of functionation of some organ or group of organs, greater care must be exercised in this preliminary placement of the case, for it is particularly in this stage of examination that many women have been assumed to have pelvic disease who really suffered from some form of nervous, constitutional, or abdominal disease, the artificial ideas of the proper position and shape of the pelvic organs yet partially prevalent among gynecologists inducing the adoption of measures that had no bearing whatever on the real affection. Chronic constipation or other functional derangement of the digestive tract, and particularly displacements and dilatations of the stomach and large intestine and relaxation of the abdominal walls, have done duty for all manner of organic diseases of the pelvic organs. But it is in the mistaking of nervous affections for pelvic diseases that the errors of apparently good diagnosticians have been most numerous and harmful during the past twenty years, due to a conjunction of circumstances such as ignorance of neurologic science; ultramechanical ideas of the position and shape of the uterus; an exaggerated belief in the frequency, effect, and incurability of ovarian diseases; and an assumption that gynecology had no relationship to any other branch of medicine than surgery.

It is to these facts that we owed the long-drawn-out epidemic of pessary wearing by women who had not the slightest need for such an unnatural and often harmful skeleton within the vagina, and that to-day we are far from blessed with the knowledge that, in the opinion of our misguided friends, about every third woman in the community must have her pelvic organs torn open, sewed up, scraped with vigor, torn loose from their adhesions, sewed up to the abdominal wall to form adhesions, cut out and put into alcohol, or otherwise disposed of. Aside from such bizarre experiences as the removal of an ovary for pain due, in reality, to lateral sclerosis of the spinal cord, and the removal of both ovaries for similar symptoms due to scoliosis of the spinal column, both of which instances occurred in cases known to the author at the hands of distinguished surgeons, my readers can doubtless recall scores out of the thousands of cases where equally vigorous pelvic treatment has followed attempts to diagnose nervous troubles obscurely pointing to the pelvis, and where the chief error of treatment was not due to a lack of the broad training that a specialist should possess, but rather to a failure to make a careful preliminary study of a case that was in itself inherently difficult of exact determination, yet which, if studied thoroughly, would have yielded negative indications at least for the radical measures employed.

It is therefore our chief duty, in these obscure cases, to determine the relation of the symptoms (1) to constipation, which is unusual in cases that are sent to the specialist in private practice, but frequent in general practice and dispensary work; (2) to other digestive, assimilative, or eliminative disturbances, such as hypochlorhydria or hyperchlorhydria, gout, rheumatism, etc.; (3) to abdominal relaxation, gastroptosis, or enteroptosis; (4) to neurasthenia or hysteria; (5) to probable neuralgia of the pelvic nerves, as evidenced by sciatic or other neuralgias; (6) to organic affections of the spinal nervous system; or (7) to true pelvic disease.

The physician who is familiar with electric methods is placed at a distinct advantage in summing up the probability of which element in the case is the prime factor of the disease when confronted with an instance in which decision is difficult, for he may embrace both horns of the dilemma with the greatest propriety and with the best results to the patient. And as the truth in the cases of moderate pelvic disease associated with a functional nervous affection often lies between the two as chief etiologic factors, no other course than the simultaneous treatment of both affections is equally effective without loss of time, money, and energy.

The ordinary questions of a careful note-taker as to family and personal history having formed the initial portion of the examination, it is immaterial whether this general examination and autoconsultation precedes or follows the local examination, provided it is given its proper place in the investigation and precedes the formation of an opinion.

Having determined that the case most probably warrants an investigation of the pelvic functions, and noted the full name and address of the patient, her age, whether married or single, and, if married, the number of pregnancies or miscarriages, if any, and the date of the most recent event of this kind, we should invariably make note of the regularity, fullness, and freedom from pain of her menstrual periods; whether she has any leucorrhea, and, if so, its characteristics as to color and consistence; and, finally, the regularity and characteristics of the alvine discharges. With these points fully noted we turn to the medical history of the case, so far as the patient can relate it, noting the years or months of its duration, with salient points of its course. Finally, we must not fail to make a note of the patient's statement of her present sufferings, their character, and the site and periods of incidence of pain, etc. More special questions, such as the presence of dyspareunia, painful coition, etc., may be reserved until the conditions found in the physical examination seem to warrant them.

Some gynecologists recommend a case-book for gynecologic cases in which each page contains a printed formula of the questions to be asked of each patient, with spaces for the answers. While such forms are useful in the subsequent compilation of statistics, the writer regards the formulæ as harmful at times, in that they tend to make the user a routinist. The most important questions in a given case are often the unusual ones, particularly in a specialty that deals with pelvic disease, neuroses, and abdominal affections, often combined in the same case. An excellent plan for note-keeping is the loose-sheet filing system, in which a folder marked with the name of the patient will hold all the written memoranda, including the attending physician's letters, microscopic examination, etc., and can be kept in a filing cabinet in alphabetical order, for immediate reference at subsequent visits.

Examination of the Abdomen.—The local examination of the patient, which should invariably be conducted with the assistance of a nurse or other third person, requires that the corsets be removed and all bandages about the waist loosened, permitting the whole abdomen to be readily examined. The patient having been placed in the dorsal position (Fig. 1) with bladder and rectum empty, the abdominal regions should receive the first attention, as inspection and palpation of this most important section of the body will not only detect or exclude disease of its various organs, but will also give important information of the general nutritive condition of the patient. To proceed at once to the pelvic examination, as generally advised in the text-books, is to overlook very valuable sources of information.

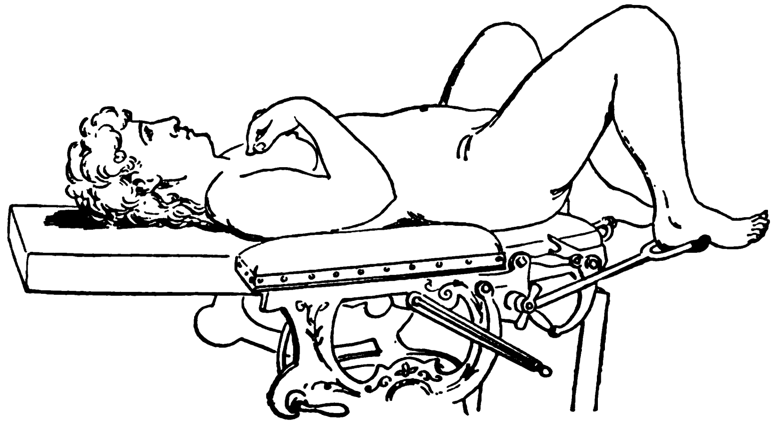


Fig. 1.—Dorsal Position. (Drawn from Photograph of Model.)

Inspection will, in addition to the information afforded as to general nutrition, give evidence of any existing or antecedent stretchings of the skin due to pregnancy, ascites, or tumors.

Palpation is most important in the general information which it gives and as a means for the discovery and the estimation of the nature, situation, and size of tumors. This should be conducted with the full palmar surface of the fingers, and not with the tips alone, and on the full education of the fingers in this art will depend much of the diagnostic skill of the examiner, the bimanual examination of the pelvis alone exceeding it in value. A form of bimanual examination of the abdomen may be of value in thin subjects in which the other hand is passed under the patient's back (Fig. 3). This will give important information concerning the true situation of the anterior hand in relation to the spinal column, the rim of the pelvis, the kidneys, and other normal structures, and permit of a more perfect appreciation of small abdominal tumors and displaced organs.

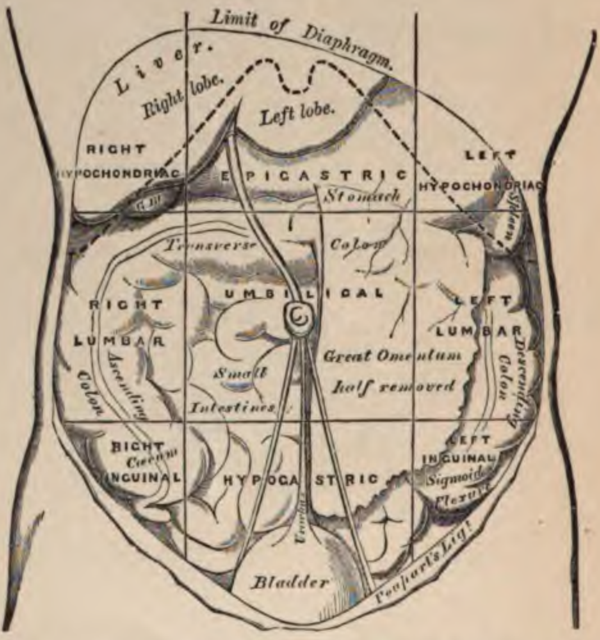


Fig. 2.—Diagram of Abdominal Regions, showing Position of Viscera. (After *Gray*.)

Mensuration.—In the larger tumors and abdominal enlargements exact measurements should be taken and recorded of the shape and size of the growth for subsequent reference in ascertaining the extent of shrinkage. The measurements are to be taken from certain fixed points appropriate to each case, such as: the height above the level of the anterior superior spines of the ilium, the distance above or below the navel, or the extreme height of the tumor from a less easily fixed point on the pubic symphysis. Measurements of the breadth of abdominal tumors may be made directly, or, in very large tumors, by taking the distance from each anterior superior spine of the ilium to the navel (in symmetrical tumors, directly from spine to spine).

Since increased health coincident with the retrogression of fibroids will, at times, be accompanied by an increased thickness or firmness of flesh in the abdominal wall, Apostoli advises that the thickness of a double layer of these tissues be taken by pinching them up in the hand and measuring with calipers. This is only of importance in accurate measurements of slight changes, for it is never great. The additional tone of the abdominal muscles under treatment is apt to convey to the patient the sensation that any increase of bulk in the latter is really a decrease.

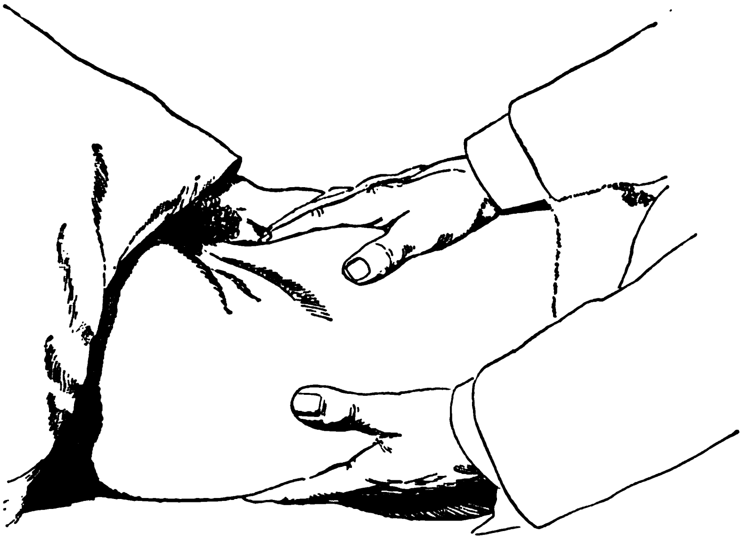


Fig. 3.—Bimanual Abdominal Palpation. (Drawn from Model.)

When the abdominal walls are relaxed, either with or without the association of tumors or other affections, the extent and importance of the relaxation is best determined by having the patient stand with abdomen uncovered or even by lying on one side. I have known patients who firmly believed that they possessed tumors, owing to the enormous relaxation revealed in the standing position, the true extent of which tax upon her strength was far from evident in the dorsal position (Fig. 4).

Examination of the Pelvis.—*Dorsal Position.*—The patient remaining in the dorsal position, an inspection of the vulva is now made in a new case for the discovery of possible evidences of a specific condition, anomalies, or of relaxation of the vulvar outlet. The next step is the insertion of the forefinger to find the position of the os preparatory to the insertion of a bivalve speculum (Fig. 5) for ocular inspection of the condition of the vaginal walls and muscular structures, the condition of the os as to the effect of previous accouchements, and the existence of laceration or of erosion. This portion of the examination has an important bearing on the accuracy of the diagnosis, since it not only informs us accurately of the existence of relaxation of the vaginal outlet and its nature and extent (see Plate

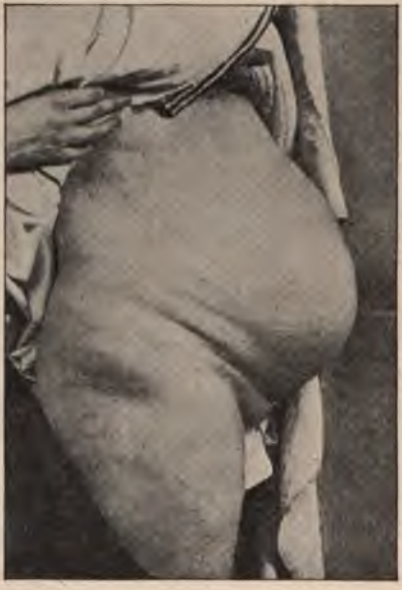


Fig. 4.—Abdominal Relaxation, as shown in the Erect Position.

XIX) and of the condition of the vaginal surfaces, but by permitting us to see the nature, color, and consistence of the uterine discharges, if any exist, also enables us to locate the origin of the discharge—a most important step in the accurate treatment of these affections. (See Plates X to XVIII.)

The Vaginal Speculum and its Insertion.—Three kinds of specula are apt to be required in the differing cases encountered in practice: the bivalve speculum; the tubular, or Fergusson, speculum; and the Sims speculum. The conditions determining the choice are quite definite. The bivalve instrument may be said to be the one best adapted to the routine examination in the dorsal position, except where cancer of the cervix is suspected, when, in the opinion of the author, the tubular instrument gives by far the best view with least pain. The Sims instrument is employed in the lateral position devised by the eminent pathfinder in gynecology whose name it bears, and is most useful in demonstrating posterior fixation of the uterine fundus and in certain surgical procedures.

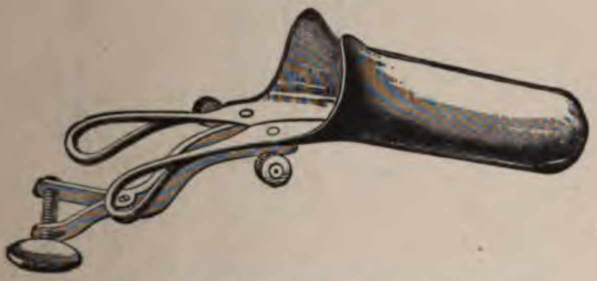


Fig. 5.—Goodell Bivalve Speculum, Latest Pattern.

Of the bivalve specula the author prefers that of Goodell (Fig. 5), as the blades may be opened by the operator's fingers instead of the screw action, thus permitting that gentleness that is always appreciated by the patient, the position thus gained being maintained, if necessary, by setting the screws. The opening may also be then widened in very patulous vaginas by tightening the thumb-screw at the bottom. A small instrument of this make is probably best for use in virgins, though the author avoids specula as unnecessary in practically every instance in examining virgins.

The bivalve speculum is inserted as follows: The examining finger, having been lubricated with sterile vaselin, is inserted into the vagina and the os uteri located, as otherwise quite a painful manipulation of the instrument is necessary in order to bring this point between the lips of the instrument. Having located the os, the finger is withdrawn and the previously warmed and lubricated speculum is gently inserted between the labiæ, which are held apart by the index and middle fingers of the free hand, *the blades parallel with the labia.* After it has been inserted about half-way toward the os the instrument is gently rotated until the blades are *parallel with the pubic bone,* the handle pointing to the operator's right. Pushing it gently on, backward, and with the tip toward the point at which the cervix is known to be, it is gently opened and the blades are made to admit the cervix, permitting a view of the os and surrounding portions of the vagina.

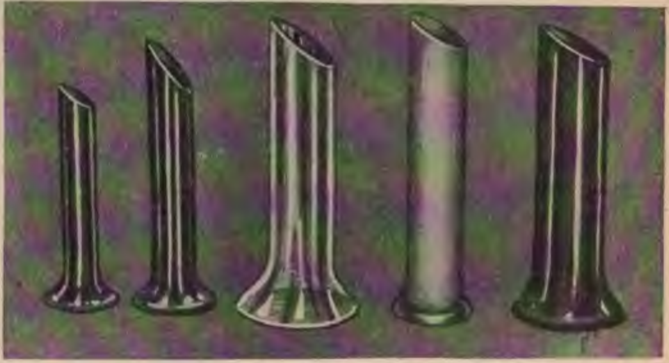


Fig. 6.—Various Styles of Silvered and Bare Glass, Porcelain, and Hard Rubber Tubular Specula.

To insert the tubular speculum (Fig. 6) the preliminary search for the cervix with the index finger may be omitted, which is often an advantage in cancerous cases, at least after a diagnosis has been made. As has been remarked, this instrument also gives least pain in advanced cancer cases, as it produces less pressure on surrounding parts. After warming and lubricating the instrument its tip is made to engage between the labia and sink deeper by a circular movement on its long axis. This turning of the instrument on its long axis is continued, a half-turn to the right, then a half-turn to the left, until, by gentle pressure, it is completely inserted, with its point behind the cervix and the latter showing freely through the open end, the spiral movements freeing the manœuver of all discomfort.[1]

The insertion of the Sims speculum is described in connection with the description of the lateral position.

Bimanual Touch.—Most valuable information of the condition of the uterine body as a whole, of the tubes, ovaries, and periuterine space, is derivable from the next step of the examination,—the bimanual touch (Fig. 7), the cultivation of which creates the true *tactus eruditus* of the gynecologist. By the educated finger within the vagina, assisted by the educated fingers of the opposite hand palpating above, a tactile intelligence may be evolved only comparable to the education of the tactile sense in the blind, capable of mapping out

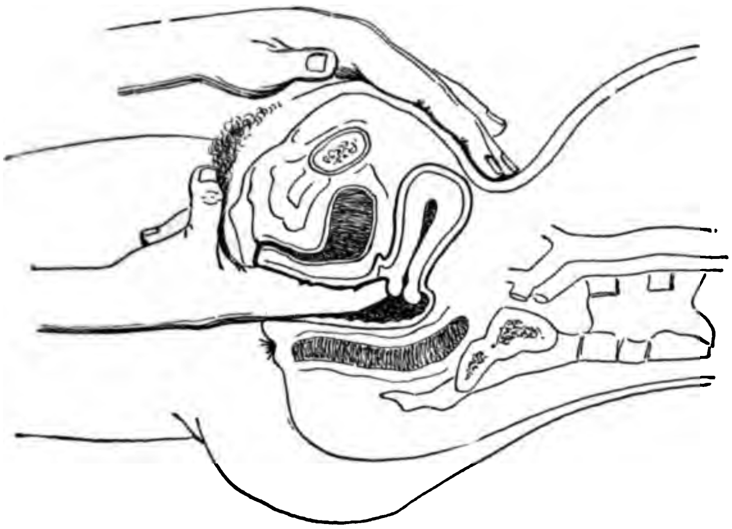


Fig. 7.—Bimanual Pelvic Examination.

---

[1] One reason for the current disuse of the tubular glass speculum is the difficulty of asepticizing it without injury to the external coating and silvering. The best way to obviate this difficulty is to use the speculum without either kind of coating, depending on a *miniature* electric lamp placed within it for lighting. The illumination in this manner is excellent, and does not require side reflection. Such simple glass tubes are easily kept surgically clean.

with precision any morbid condition within the pelvis, unless the subject is inordinately obese. It is not claimed, of course, that the exact nature of the morbid condition may be thus determined, though the association of subjective and other objective symptoms may enable us to come very close to it; but it is claimed that the educated touch is capable of making a diagnosis that will fully warrant the institution or rejection of electric or other conservative treatment, if it could not so easily warrant a major operation. An intra-uterine treatment constitutes also an additional means of diagnosis (page 138), as pointed out by Apostoli, thus rendering absolutely unnecessary that terrible alternative advocated by some—an abdominal section for diagnosis.

The Sound.—Nothing has been said of the passage of the uterine sound (Fig. 8), for the simple reason that the author condemns it as a means of diagnosis in any form of uterine trouble except tumors, for the reason that all of its indications, except the depth of the cavity, can be determined with equal facility by the skilled bimanual touch. The depth of the cavity is of value as a means of comparison from time to time and may be taken during any intra-uterine applications that are made. An exception to this condemnation of the sound is imperative in the first examination of fibroids, and in the discrimination between these neoplasms and ovarian tumors or other periuterine tumors closely approximated to the uterus. When so used it should be inserted without a speculum by passing the tip along the index finger previously placed in the vagina, the instrument being held very lightly between the index finger and thumb of the opposite hand, thus enabling it to be inserted with the utmost gentleness. After engaging the cervix the handle is brought down between the thighs to enable the curved portion at the tip to coincide in direction with the cervix, as it is known to be at the moment by the touch, and when thus inserted it may be made to follow the actual direction of the cavity with least disturbance, the sound becoming a prolongation of the delicate tactile organs of the finger. This method of inserting the sound has been popularized by Apostoli,

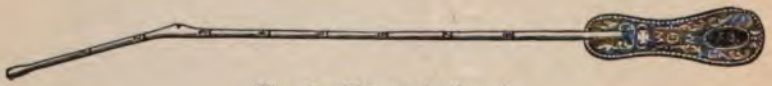


Fig. 8.—Simpson's Sound.

and, when one is familiar with it, its immense advantage over any other method in which the touch does not take part is most evident. The cut (Fig. 9) has been carefully drawn to illustrate the method as practiced by the author, showing the finger behind the cervix, which it draws slightly forward when this portion of the uterus points too far back.

A method of insertion of the sound practiced by some, in which the cervix is caught with vulsella forceps and dragged downward, should be condemned as unnecessarily barbarous, liable to produce injury if the adnexa are adherent, and unable to convey to the operator any intelligent information as to the direction in which the instrument should be passed.

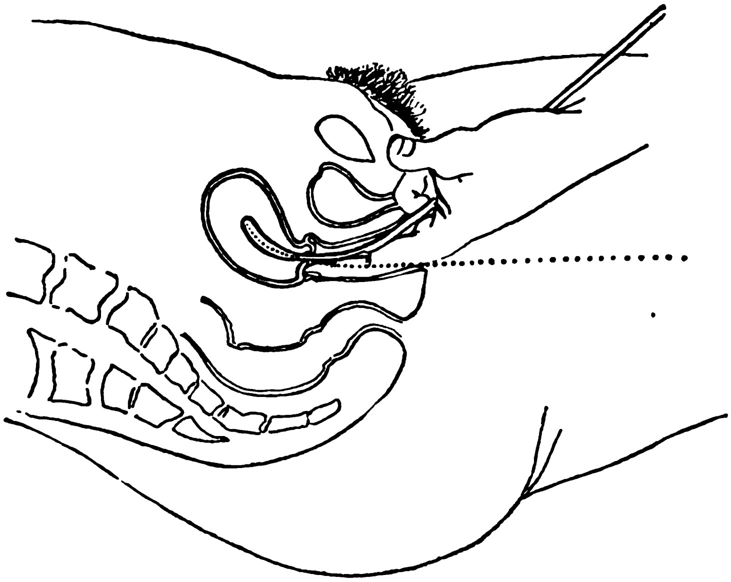


Fig. 9.—Method of Inserting Sound by Touch. The Finger is shown Behind the Cervix.

Abdominal palpation may be conjoined with the sound in the differential diagnosis of tumors projecting above the pelvic brim, a slight movement being given to the uterus to determine whether it is intimately connected with the tumor.

Rectal Touch.—This is an important proceeding when the vaginal touch has disclosed obscure conditions in the posterior pelvic regions, and should be practiced just before the termination of the examination on account of the fingers becoming soiled. It is also of great value as a sole means of examination in virgins. The bimanual rectal touch is practiced in the same manner as the vaginal procedure.

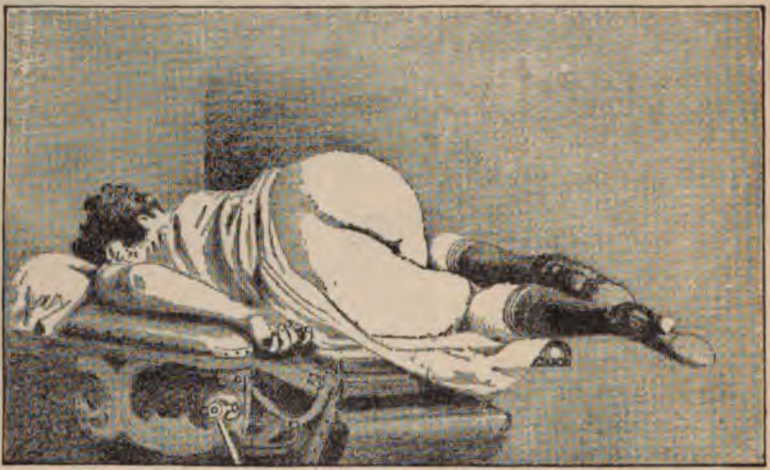


Fig. 10.—Sims's Position. (From Photograph of Model.)

Sims's Position.—The use of Sims's position (Fig. 10) and speculum (Fig. 11) are far less frequently necessary in the conservative treatment of the diseases of women than in operative procedures, though, at times, valuable in applications to the cervix and vault of the vagina and in electropuncture, though even in the latter operation the dorsal position is preferable for any but the most superficial punctures, on account of the use of the finger in directing the instru-

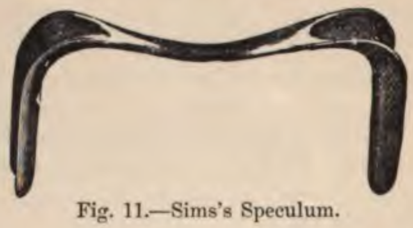


Fig. 11.—Sims's Speculum.

ment. The proper attitude for this examination is shown in the cut, the side of the table on which the hips rest being slightly elevated to raise the vulvar outlet above the level of the vault in order that pneumatic pressure may dilate the vagina when air is admitted. The speculum (Fig. 11) should be inserted by separating the labia with the fingers of the left hand, holding the instrument in the right by its opposite extremity; the point of the blade is placed on the posterior commissure and slipped into the vagina in a backward and upward direction. After adjusting the tip in a manner to bring the desired portion under view the instrument is intrusted to the nurse, who stands with her left side toward the patient (Fig. 12).

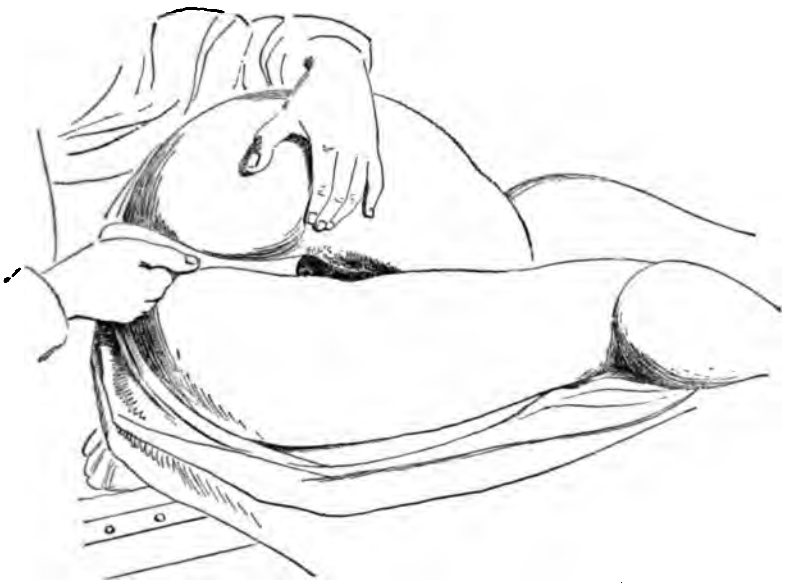


Fig. 12.—Attitude of Nurse in Sims's Position. (Drawn from Photograph of Model.)

Posture.—When the dorsal examination reveals much relaxation of the vulvar outlet, or prolapse of the uterus, the true extent of misplacement of the latter organ cannot be determined until a digital examination is made with the patient in the erect position.

The knee-chest position (Fig. 36, page 79) is also quite essential in cases of retroflexion or retroversion to determine if the uterus is adherent posteriorly. If this be the case the condition is revealed in the most effective manner when the vagina is inflated by the pneumatic pressure.

Illumination of the Vagina.—A light from a northern exposure is generally sufficient for an ordinary specular examination, but in its absence, or when minute inspection is necessary, no method of illumination is equal to the miniature electric lamp of 4 or 6 volts' required pressure. All headlights have been practically abandoned since the appearance of the previous edition of this work as far less convenient than direct illumination, the employment of the latter having been greatly stimulated of late by the invention of the dry cell and the volt selection controller, which have rendered the troublesome acid primary cells and storage batteries entirely unnecessary. While these little lamps are credited with giving but from 1 to 4 candle power, it should be remembered that this amount of light is *concentrated in the immediate vicinity of the illuminated object*, and is therefore equal to a much greater light unconcentrated. The miniature lamp, moreover, does not require a fixed position of the observer's head, and permits the eye to come in closer range with the part inspected.

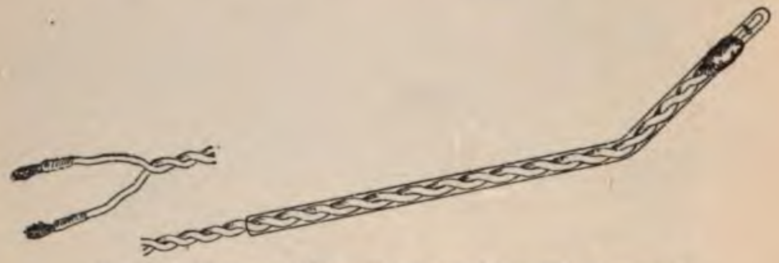


Fig. 13.—Miniature Diagnostic Lamp Mounted on Aseptic Glass Tube Holder.

The placing of the lamp within the vagina, rectum, or throat necessitates one disadvantage nevertheless, viz: the added necessity for maintaining absolute cleanliness of the lamp and lamp-holder. Some of those on the market could be improved in this respect, though many have the requisite slenderness required to avoid obstructing the view within a small speculum. Whatever the material of the lamp-holder, no instrument with the lamp attached by a screw thread can be cleansed in disinfecting solutions without rusting at the joints.

These considerations influenced the author in devising the simple improvement in the mounting of a miniature lamp shown in Fig. 13, in which an ordinary bent medicine tube of glass is made to do duty as a holder, the end of the glass tube and the bulb of the lamp being made continuous by fused shellac or sealing wax, permitting the whole length of the instrument to be repeatedly subjected to disinfecting solutions, hot water and soap, and even gentle heating without injury. The lamp is attached to the double-cord conductor directly, the wire terminals being twisted about the bared end of each conductor of the cord, each conductor being then coated with a thin covering of fused wax. The cord is then drawn through the tube, the wax gently melted, and, the end of the tube being hot, the whole can be pulled into place by slight traction and the joint sealed by reheating the wax. A 6-volt dental lamp with unmounted terminals may be procured for the purpose from a dealer in electric supplies, and when burned out a new one may be attached to the cord and tube in the same manner.

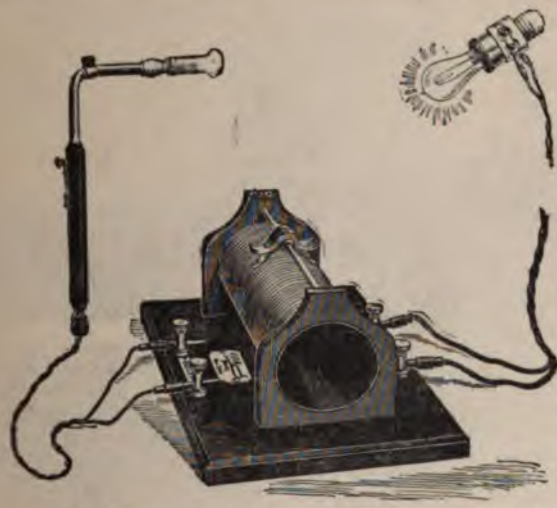


Fig. 14.—The Meyrowitz Volt-controller for Diagnostic Lamps.

When the source of the current to be used is the 110-volt direct current a volt-selecting controller must be employed. This may be the author's new volt-selecting graphite controller (Fig. 111, page 333) which is equally good as a miniature lamp and general therapeutic controller, or the special wire controller for miniature lamps, such as is shown in Fig. 14.

If the supply current in the physician's office is of the alternating variety, a "step-down" transformer should be employed (Fig. 15), in which the higher voltage is passed through a long primary wire and the low-voltage lamp current obtained by induction from a short secondary wire, the apparatus being similar to a medical induction coil reversed, the current being turned on the lamp by passing the secondary over the primary exactly as in the therapeutic apparatus.

For a portable apparatus the same 6-volt lamp may be attached to the terminals of a portable box containing four Columbia dry cells of ordinary size, the slight excess of voltage being controlled by a little resistance coil between the last cell and one of the binding posts. When exhausted these cells are easily replaced by the physician, the connections being in series.

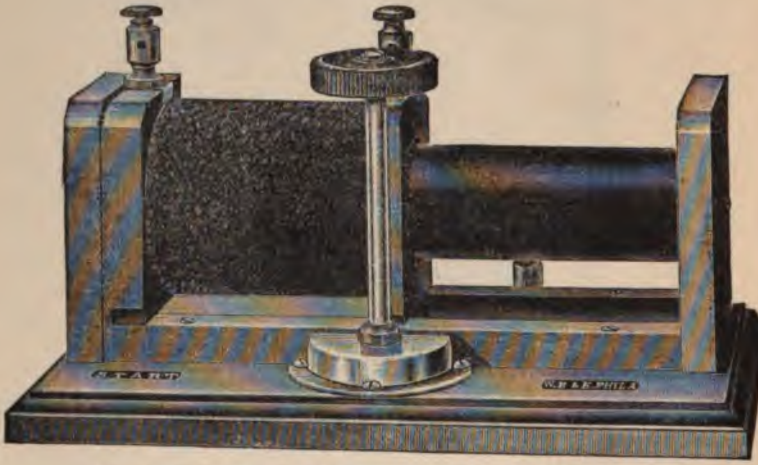


Fig. 15.—Alternating Current "Step-down" Transformer.

But by far the most conveniently portable outfit is that in which three miniature cells inclosed in a pasteboard case are just the right size for the coat pocket. New sets of these cells are sold cheaply in many electric supply establishments, and they light up a 4-volt lamp (which may be mounted on a short length of glass tubing for convenience) without the necessity of any controlling device.

Transillumination of the Pelvis.—The fact that limited thicknesses of the body, such as the finger and part of the palm, may readily become translucent to the rays of even a moderately strong light seems to have been lost sight of as a means of diagnosis until the laryngologists took it up in 1888, when Cozzolino, of Naples, followed by Voltolini, of Breslau, illuminated the walls of the nose and accessory cavities and the larynx; the former by miniature lamps within the closed nostril or mouth, and the latter by a lamp on the outside of the neck, covered by an obturator, the light being perceived by the use of a laryngoscopic mirror within the dark pharynx.

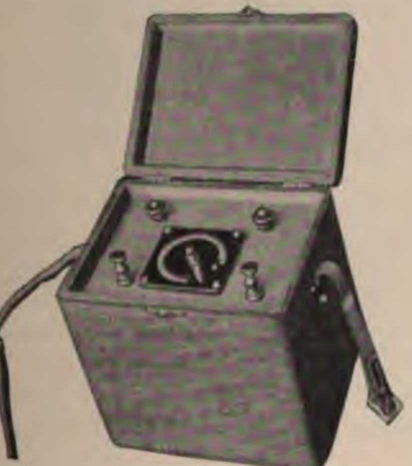


Fig. 16.—Portable Dry Cell Battery for Six Volt Miniature Diagnostic Lamp, containing Four Dry Cells, with Controller.

The application of the principles thus disclosed to gynecology has been retarded by the greater thickness of the body in this situation, rendering the miniature lamps that are capable of being introduced ineffective as a source of light. I have, however, myself succeeded in illuminating the abdomens of moderately thin women by the lamp devised by me (Fig. 18), which consists of a 6- or 8-volt lamp mounted on a holder in front of a plane reflector, and the whole inclosed within two test-tubes separated by rubber bands. The special advantage of this arrangement is the two air-spaces separated by the test-tubes, reducing the radiation of heat and permitting ready cleansing. The abdomen is illuminated by a reddish glow half-way to the navel. This light is, however, insufficient to illuminate the tissues in case of fat, or corpulent, patients, and, as the value of the procedure hinges on the absence of transmission as an evidence of pus accumulations and possibly tumors of dense consistence, it is evident that a more powerful light is necessary.

Fig. 17.—Pocket Battery of Dry Cells for Miniature Diagnostic Lamp.

Another mode of obtaining transillumination of the pelvis is to place a 32- or 50-candle-power lamp over the abdomen in a conical receiver made to exclude all light except that which traverses the skin and abdominal walls; if a glass speculum be then placed in the vagina the tissues will be seen to transmit a red glow.

All work in transillumination should be done in a thoroughly darkened room.

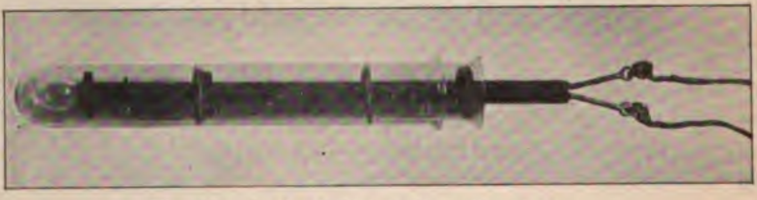


Fig. 18.—Author's Pelvic Transilluminator.

The value of transillumination is limited by the fact that all living tissues appear nearly the same in color and shade. It is impossible to make out the anatomical parts except the large veins and the bones, and these only by a darker shading. Accumulations of pus will appear as a dark shadow, while cystic tumors are lighter than their surroundings. No light is transmitted if there be extensive exudations, and dense fibroids and possibly cancerous tumors cast a shadow or interfere with transmission. Hematomas should also be opaque, if the general rule holds good that dead tissue is opaque to the rays.

With a satisfactory source of light, the value of this procedure in diagnosis is evident.

Aspiration. — A most important occasional means of positive diagnosis in some pelvic and abdominal tumors where a cystic condition is suspected is the puncture of the tumor by a long slender needle with capillary tube, attached to an aspirator, by which we may determine the presence of a liquid and extract a portion of it for diagnosis, and also in certain cases as a remedial measure (Fig. 19). The delicate nature of these needles makes it possible to traverse many organs and tissues with impunity, though the careful operator will usually be able to insert it quite directly into the presenting portion of the tumor without taking unnecessary risks. The imprisoned sac in intestinal hernia, the bladder threatened with rupture, and the large intestine distended with gases have all been safely punctured with this instrument, and the needle may be used as a negative electrode when inserted into a tumor, if thought wise, after the liquid has been withdrawn, by previously coating it with a thin layer of fused hard rubber to a short distance from the point, and connecting it

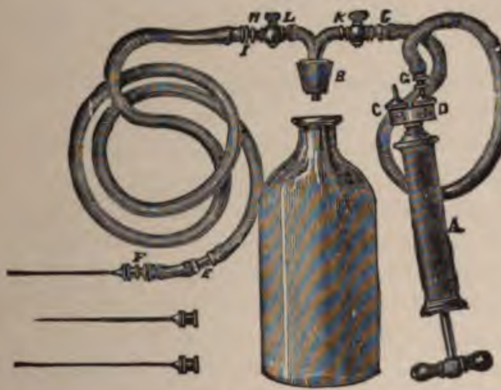


Fig. 19.—Aspirator.

with the negative pole of the battery by twisting a fine copper wire about its base. When so used the hydrogen-gas and liquids of electrolysis are drawn into the aspirator reservoir in great quantity.

The aspirator acts, of course, on the principle of producing a vacuum in the reservoir-bottle by means of a suction air-pump connected with it by a stout rubber tube, the needle being attached to another tube connected with the top of the reservoir.

Great care should be observed in asepticizing the needles and tubes before and after use, the needle being either boiled or passed over the flame of an alcohol-lamp immediately before use, no matter what the previous cleaning may have been, and the spot where it is to be inserted should be cleaned with sublimate solution if within the vagina or sublimate solution followed by alcohol if on the abdominal surface. Chloride-of-ethyl spray will make the external puncture painless.

Aseptic Precautions in Routine Gynecic Practice and Electrogynecology.—The hands, and particularly the fingers and finger-nails, should be scrupulously clean when making any examinations or applications, the use of the nail-cleaner, scrubbing-brush, and soap and water being amply sufficient when the mucous membrane is unbroken. No instrument of any character should be employed unless absolutely aseptic, the author making the following arrangements for this purpose: *All sounds and intra-uterine electrodes are first thoroughly washed in soap and water and then passed through the flame of an alcohol-lamp or Bunsen burner,* and no instrument of this nature is inserted into the uterus that cannot be so asepticized. *All metal instruments likely to be injured by this heat,*—such as specula, forceps, etc.,—*are boiled before use.* Electrodes with rubber insulation not fused on the shank, which I reject, when possible, in favor of those that have a fusible insulation, are dipped in boiling water and thoroughly scrubbed with soap and water, or are kept in a 3-per-cent. solution of carbolic acid or creolin. The electrodes with fusible insulation are *heated in the flame and asepticized by re-fusing the covering.* All cotton pads or other external electrodes that are used for more than one patient are boiled before use, a small gas-stove being very convenient for this purpose.

CHAPTER III.

INTRODUCTORY REMARKS ON ELECTRICITY AS A REMEDY IN GYNECOLOGY.

THE systematic use of electricity in certain affections peculiar to women had its inception in the labors of Tripier, who, as far back as 1859, began a series of publications that show a profound study of the value of electricity in the trophic and mechanical lesions of the uterus and other pelvic organs. Numerous and fruitful essays have appeared from the same pen at frequent intervals since, the whole amply sufficient in themselves alone to stem the tide of excessive surgical interference in gynecology that began simultaneously with his work, but outstripped it so widely. But Tripier has not been understood by his contemporaries. Electro-therapeutics itself and all writers on it were assumed to be concerned with nervous diseases alone, and what literature existed was inaccessible to gynecologists. It remained for Apostoli to successfully attract the attention of specialists in the diseases of woman by the persistent advocacy of his discovery of the value of scientifically applied currents in the treatment of fibroid tumors, by methods that resulted in a distinct advance in the general application of electricity in medicine. This invasion of what had been regarded as an exclusively surgical field received conspicuous and bitter criticism from the many stalwart defenders of a faith that laid aside all else in gynecology but the knife. In America and England particularly the discussions have been numerous and acrimonious, and doubtless many extravagant claims appeared on both sides; but as a result it may be said that electricity has been rescued from its exclusive position as a toy in the hands of the neurologists, too many of whom intrusted its crude applications to unintelligent nurses. and has won for itself an important place in the curative therapeutics of gynecology. As a natural consequence, an improvement has also appeared in the application of electricity to nervous diseases—a result that could not have been hoped for under previously existing conditions.

Apostoli's work was, of course, but the medical application of that swelling tide of electric knowledge that has so suddenly altered the mechanical surroundings of mankind. It was, indeed, high time that the recent advancements in electric science should be applied to medicine, its oldest service to man, when Apostoli described, in 1882, his device of the clay-pad diffusion-electrode for the painless dispersion, on the outside of the body, of the powerful, measured currents concentrated at will within. Conceived on lines previously enunciated by Erb, the method was the first demonstration since the era of electric measurement of the possibility of using really effective currents within the body.

How Electricity Becomes a Remedy.—The intimate connection between electricity and physiologic and pathologic processes has recently been considered by Prof. A. E. Dolbear, the eminent physicist of Tuft's College, Cambridge, Mass., in a paper read before the American Electro-therapeutic Association at its Boston meeting in 1896. He deprecated all allusion to electricity as a force external to matter and independent of it. Electricity, light, heat, and chemic action are inherent properties of matter, electricity being the rotatory property of atoms, light the vibratory property, etc. They are but manifestations of atomic energy which are continuously present in the interchanges of atoms in the molecular activities incident to life. The higher the form of tissue, the greater the amount of energy absorbed in cellular activities.

"The factors of physiologic phenomena are the kinds of matter found in organic things and the kinds of motion and energy which give the kinds of matter their characteristic properties. The phenomena exhibited with these factors depend upon the inherent qualities of the atoms themselves, and it is certain that the old notions concerning their nature and possibilities must be profoundly changed, for the old is altogether inadequate and no one to-day knows enough to say what matter cannot do, for such a one makes ignorance do duty for knowledge. What can be strongly stated is that the variable factors are heat and electricity, for these determine chemic reactions, in the body as well as out of it. For a long time heat was the only physical factor employed for chemic purposes in inorganic processes. Lately electricity has been utilized and has made possible many reactions which were either impossible or required a long time to effect, such as the reduction of alumina, the tanning of leather, and the making of potassium chlorate and sodium carbonate. Is it not altogether probable that the selective chemistry of tissues of all kinds is to be helped in like manner by employing the same agent, and that only present lack of knowledge prevents its successful use in promoting normal physiologic processes and destroying abnormal ones? Anthropologists are telling us there are few, if any, individuals of any race that are thoroughly sound, that all are in a more or less diseased condition. That means that cellular structure does not distribute to physiologic structure the proper kind and amount of physical energy needed. The trouble is with the cells, not the organs. And the trouble with the cells is instability due to lack of available energy, ultimately electric, if there be any truth in what seems to be implied in all molecular structure, for every atom has its electro-chemic equivalent or electric energy, which is disposed in this way or that as it is held more or less stable in its molecule."

This suggestive extract from Professor Dolbear's paper gives unquestionably the true basis of the medical value of electricity. In brief, it may be said that by its use we have a means of altering at will the molecular activities, the selective chemistry, of both superficial and deep-seated parts of the body, and this is done, not by the addition of foreign substances or even a foreign force to the body, but by a simple alteration of its cellular activity, on which all organic functions depend.

To affect molecular activities in a special organ, which may be deep-seated, it is therefore apparent that we must so concentrate our "current" of rotatory molecular excitation from some artificial source external to the body that it may traverse that organ and be dense enough in transit to accomplish its purpose. This current, which, if constant, is always issuing from its source in a definite direction, only circulates when the path back to its source or to earth is complete. To place the body in this path or circuit we must apply two conducting contacts (electrodes) to its surface or within its substance, between which the current will spread out as it traverses the intervening tissues. The electrode at which the current enters the body is called the positive pole, or anode, and is generally indicated by the + sign; that at which it leaves is called the negative pole, or cathode, denoted by the — sign. In addition to the molecular excitation referred to, which is present in all portions of the circuit through the body in proportion to the local density of the lines of flow, special chemic and molecular effects on living tissue attend the current at entrance and on leaving the body; hence the two poles have distinct and separate physical and therapeutic effects (page 48).

It is only necessary to add to these hints at the mode of action of electricity as an internal remedy that an intensification of the same molecular activities by concentration of the current is the explanation of the destruction of tumors of the body-surface and accessible cavities by ordinary electropuncture, where molecular activity is conducted to the final step of a resolution of tissue into its ultimate inorganic elements, and that in the phoretic powers of constant currents we have an invaluable assistant in the introduction, into any given part of the body, of medicaments in nascent form and capable of definite concentration in an organ without flooding the whole body with the remedy.

Special Value of Electricity in Gynecology.—The foregoing remarks indicate the basis of a wide applicability of electricity to the cure of diseased organs in general. That its value in chronic affections of many kinds is but imperfectly appreciated by the profession is only too true (and this may be largely imputed to its but recent availability in mensurable quantity), yet there are two special reasons for its recent agitation as a remedy in the diseases of women. One of these is the prevalence of nutritional and functional affections of the uterus and adnexa readily cured in this way, and by currents easily made effective owing to an insensitive nerve-supply. The other reason is that it offers a choice of treatment in a class of affections notoriously maltreated at present by methods almost invariably involving the sacrifice of organs.

It is, of course, by no means within the power of electro-gynecology to displace the really necessary work accomplished by the modern methods of aseptic surgery, but it is within its province to demonstrate that mutilating and sacrificial operations can be restricted to cases legitimately requiring such measures of last resort by revealing the curableness of many affections apparently regarded as hopeless. The extensive prevalence of an attitude that regards the removal of an organ as both the proper and the only way to cure it can only be regarded as the sign of a mental epidemic of no mean proportions, particularly when such attitude is maintained only toward one set of organs.

To check microbic invasion and its consequences, remove pain, restore function, correct nutritional faults, check hemorrhage, cause retrogression of benign growths, cure malignant growths, and restore local and general health is a sufficiently broad platform for a single agency, and, if these or many of these results can be accomplished by electricity without danger, risk, or mutilation, its claims for consideration as a method of choice over less advantageous procedures are imperative.

With powers so conservative, yet vigorous, at command, it is clearly the duty of the electro-gynecologist to protest against the too common practice that classes gynecology with major surgery alone, and results in sufferers from the diseases of women being referred at once to specialists in abdominal surgery. No organ should be subjected to a mutilating operation, certainly none removed from the body, until the powers of conservative medication have been intelligently tested; yet such is the haste in the performance of this work of last resort that our hospitals particularly have become the sacrificial temples of this new faith, in which women by the score, without previous attempt to cure, are persuaded to undergo operations dangerous to life and unwarranted by sound judgment, and which are followed by lifelong consequences in those that recover that are either carefully concealed or else carelessly withheld from their knowledge before their consent is given.

Special Value of Electro-gynecic Applications to the General Practitioner.—Besides the opportunity that is afforded to the family physician in the reference of his more difficult cases to the electro-gynecic specialist for an application of the highest skill in the art to a truly conservative restoration of health, a mere superficial employment of this agent by himself is calculated to be of immense service to his patients in the cure of many deviations of function which may have seemed great enough to demand a reference to others. And this large field of usefulness is entirely wanting in risk, even in unaccustomed hands, if the vaginal methods of application are adhered to and the intra-uterine applications withheld until greater expertness is gained.

That a large proportion of the ordinary cases of pelvic pain and discomfort are mainly due to deficient muscular and nervous tone, to relaxation, to the consequences of sexual excess, and to congestions and inflammatory sequels easily removable by the stimulant and tonic effects of vaginal applications of the induced current is well known to every gynecologist who sees a large number of semi-acute cases, and there is no reason why these cases should not be treated by the intelligent general practitioner with an office practice, particularly when continued delay or the application of harsh remedial measures will lead to an intensification of the trouble. This was well illustrated by a story told by Dr. Lapthorn Smith, of Montreal, who had recommended a physician to purchase an induction apparatus, and on calling at his office some time subsequently was surprised at its worn condition. The physician explained matters by asserting that he had cured a considerable number of patients by its use. When asked what had been the matter with the patients, he could only reply that he did not know, but that they had been cured, nevertheless. The interests of exact science condemn such blind empiricism and routinism, but, when it is remembered that the remedy employed by him is incapable of harm, no one can say that this physician was wanting in either common sense or humanitarian principles.

Limitations.—An attempt to assign exact limits to the medical usefulness of an agency such as electricity will remain impossible for some time, owing to the varied nature of the conditions attending its employment. One may believe, for instance, that ergot, iodine, or other material agent may be thus easily understood, but the agent, in this case, being *the intensification or alteration of the molecular activities in a controllable manner,* with immediate results varying through an enormous range of current-strengths and qualities, the field of usefulness is more widely varied, and it is probable that conditions yet regarded as incurable in this way may merely require a heavier or more skillfully applied current. It is true, nevertheless, that many limitations to its usefulness are at present apparent, in the discovery of which a large and constantly increasing list of valuable uses has been established.

No claims that electricity, or, in fact, anything else, is a cure-all are possible to the scientific mind, and, although these pages are largely devoted to a demonstration of its value in the definite conditions enumerated, it is not supposed that the reader is to neglect any simpler means that would be effective in the treatment of his cases; for approved medical treatment, including the use of internal remedies or of applications capable of being administered by the patient, are always preferable to remedial means that require the physician's personal attention, provided the same ends can be accomplished.

A similar discretion is also urged upon the part of the reader in the choice between electricity and the knife, *electricity being advised only when it is equally certain in effect, free from danger, and more* *conservative of organs and their functions;* and, unless experience shows us that all or most of these advantages are assured as a result of the electric treatment of a particular case, we should not lose time by its employment. It should not be forgotten, nevertheless, that in case of uncertainty on these points a course of electric treatment is incapable of doing harm, and, in the event of failure, leaves the patient in a position to derive full benefits from surgical treatment, which cannot be said conversely of patients who have failed of relief under a surgical operation.

CHAPTER IV.

PHENOMENA ATTENDING THE TRANSMISSION OF CONSTANT CURRENTS THROUGH LIVING ORGANS.

Physical Reasons for Electrode Coverings.—With low-pressure currents, such as the constant and induced, it is essential that a good contact be made between any two parts of the circuit, since these currents have very slight power to jump through the air. In the human body the moist tissues are the conductors, which, in percutaneous applications, we find surrounded by an insulating envelope of dry cuticle, presenting, together with the slight layer of air between it and the dry metallic-electrode surface, a very large amount of resistance. One important purpose of an electrode covering is the maintenance of a moist conducting-joint between this metallic surface and the moist, subdermic tissue, the water contained in the covering not only blotting out the air-cushion beneath the electrode, but rendering the cuticle itself a better conductor by soaking it. It is true that a little current will be apt to pass from a dry metallic surface to the body with currents of a pressure of 50 or 100 volts (such as with the constant current brush), but the lines of potential will be almost exclusively within the skin rather than beneath it. In other words, the energy of the current will be chiefly expended here, making the application practically one to the skin only (see Experiment 5, page 352). Deep penetration of the current is then a prime reason for a well-moistened electrode covering, with the associated fact of a minimum of dermic action and pain. Another important use is the protection of the surface from certain chemic and electrolytic polar effects when they are not desired. When we wish to make use of these effects to their fullest extent provision is made for an immediate contact between the metal and moist tissue, as by puncture through the skin or by simple contact if it be a mucous surface.

Fresh absorbent cotton, which was first recommended by the author as an electrode covering in 1885, remains, in his opinion, the most cleanly, easily applied and renewed, and generally useful material for this purpose, the accuracy of its contact with the skin being, however, greatly increased by thoroughly soaping its surface. In 1882 Apostoli introduced well-moistened sculptors' clay as the material for the large abdominal pad when it is desired to render one pole nonactive, or capable of transmitting a large current with a minimum of sensation and local resistance at this spot. If thoroughly adhesive it has an advantage possessed by no other material in accuracy of contact, which practically broadens the path through the skin.

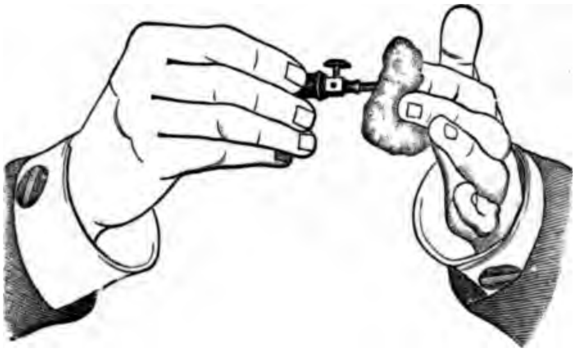


Fig. 20.—Applying Absorbent Cotton to Electrode Disk (First Stage).

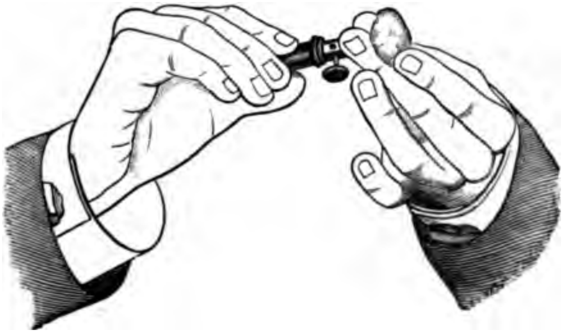


Fig. 21.—Applying Absorbent Cotton to Electrode Disk (Second Stage). The disk is rotated between the fingers until the cotton is firmly attached.

Current-diffusion Within the Body.—The subdermic body conducts currents with a reasonable ease because of its saline constituents in watery solution. Grossly speaking, those parts that are most watery are, therefore, the chosen paths of transit through the body, a greater proportion of current going through the soft tissues around bones and nerves than will take the apparently shorter cut through them. Such considerations are important when we are compelled to depend upon interpolar action for therapeutic effect, and desire to send a dense current through a region beyond immediate contact with the electrode. Of still greater importance is a clear idea of current-diffusion in the body as a whole. To suppose that we can send a current through the body like a straight beam of light, or even in the bellied cylinders depicted by Erb, is to ignore well-known laws of resistance and current-diffusion. The author pointed out some years ago[1] that a demonstration of the real facts of much importance to physicians is contained in Prof. W. G. Adams's experimental measurements of current-diffusion within masses of salt water.[2] Buckets and tubs of salt water and various acid solutions were used for experiments, the character of the solutions and the shapes of the utensils presenting conditions closely analogous to the human body. To illustrate the facts thus verified, I have drawn three diagrams (Figs. 22, 23, and 24) in which the behavior of a current traversing narrow and wide conductors is shown. The lines of flow are seen in each instance to cross the dotted lines at right angles. These dotted lines are lines of equal potential. Exactly what equipotential lines in electricity are can be best understood when it is known that they are analogous to the edges of the steps of a staircase down which a water-current is flowing. In this case it is assumed that the middle step is zero, or at the level of the earth (making it analogous to a staircase with the middle step at street-level, and each half of the remainder going upstairs and down cellar).

In the narrow conductor (Fig. 22) the equipotential lines, or, in illustrative language, the edges of these steps of electric level, extend straight across the conductor, the lines of flow being straight lines from pole to pole. In the wider conductor (Fig. 23) the lines of potential tend to curve somewhat about the poles; hence the lines of flow on either side of the central one, which remains straight, curve a little also, as the potential lines must be crossed at right angles.

---

[1] Journal of Nervous and Mental Disease, No. 7, 1886.

[2] Proc. Royal Society, vol. xxiv, page 1. See, also, a theoretical discussion by Foster and Lodge, Proc. Lond. Phys. Soc., vol. i, page 113.

When the current is passed through so large a conductor as the human body (Fig. 24), the potential lines become arcs of small circles

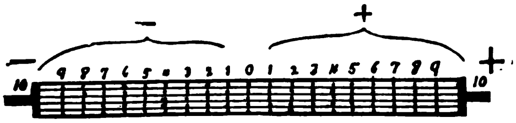


Fig. 22.—Diagram showing the Distribution of a Current of 20 Volts within a Narrow Conductor. The milliampères are equally distributed in the lines of flow (represented in the cut by horizontal lines). The lines of equal potential (represented by dotted lines) are drawn 1 volt apart, and have a value indicated by the figures.

about each pole, the size of the circles rapidly increasing as the lines of flow proceed away from the pole. The lines of flow traverse every portion of the conductor as before, crossing the equipotential lines at right angles, and differ in amount of current carried only in inverse ratio to their length.

It is necessary to add that these diagrams represent the distribution in a homogeneous conductor, such as a single organ, and that

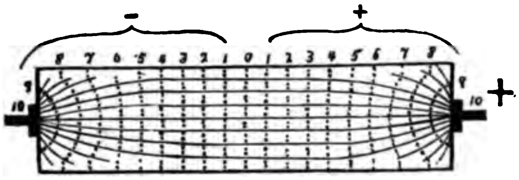


Fig. 23.—Distribution of a Current of 20 Volts within a Wider Conductor. The lines of flow on either side of the central one curve somewhat, as do also the most positive and most negative potentials.

slight alterations would be required to make them represent accurately any composite conductor like the body. An accurate chart of the soft parts, nevertheless, would only add waviness to the lines as drawn, though bones and bony cavities would deflect them greatly. It should also be remembered that the diagrams represent a section only, and that the equipotential lines are, in reality, cup-shaped planes through which the lines of flow spread in all directions.

Current-concentration.—It is the converse of these facts of current-diffusion within the body that it is difficult or impossible to bring a concentrated current to bear on organs or growths that are far beneath the surface, the nearest approach to concentration at a distance requiring a very heavy current at the polar contacts. Now, the effects are proportional to the concentration as well as to the strength of the current; that is, 10 milliampères will act with twice the strength on a surface of one centimeter that they will on two centimeters; hence the field of application of concentrated currents is far greater in what is called the polar regions, or in the immediate neighborhood of the poles, than in any other portion of the circuit.

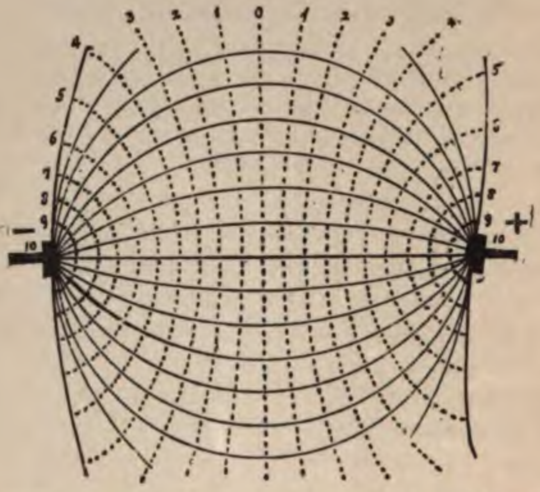


Fig. 24.—Distribution of a Current of 20 Volts within the Human Body. The equipotential lines or planes become segments of perfect circles, and the lines of flow, necessarily crossing the latter at right angles, become greatly curved and extend to all parts of the body in passing from pole to pole. The number of milliampères traversing the lines of flow differs somewhat, being inversely proportional to the length of the lines.

It will be noted also, by a reference to the cuts, that in a large conductor such as the body the current will so spread out after entering it that it cannot be said to traverse a nerve or other structure beneath the pole in any special direction, since it traverses it, in fact, in every direction. These considerations, together with important electrolytic and phoretic actions at each pole, result in making a constant current application practically an application to an organ of a certain polarity to a variable surface and depth.

At the surface itself the effects can be accurately gauged by a combination of the three elements of strength, duration, and concentration, the cauterant effects to be described later being particularly dependent on the polar concentration, which is determined, in applications to mucous surfaces, by the extent of the electrode left uncovered by insulation. With an intra-uterine electrode, for instance, having a bare surface extending two inches back from the point, 20 milliampères may not cauterize in three minutes, but may cauterize slightly in five. Fifty milliampères can be used with a bare electrode of greater size in the vagina under the same conditions, with about the same result. On the other hand, $^1/_2$ to 1 milliampère, applied on the point of a fine needle, as in the epilation of hairs, will cauterize in a few seconds.

Polar Regions.—The area beneath each electrode, or around it if placed within the body, where the current-lines are densest and the polarity most positive or negative, is called the polar region, the intervening space being interpolar. Besides the results due to the usual concentration at the polar regions, certain chemic and vital effects noted below appear in these regions only, rendering them the most effective situations for electric application. Yet a diminishing polarization extends deeply into the body from a strong current, being *nil* only in the center, and the lines of flow, though greatly dispersed at this depth, extend completely through the body. This intermediate region is called the interpolar region (Fig. 25).

Within the interpolar region the interstitial and cellular irritation incidental to the transmission of the current and of the electrons that appear naked at the poles is the chief basis for therapeutic results, while in the polar regions the chemic action of these particles, as described below, is supplemented by another set of phenomena due to the behavior of nerves when under the influence of concentrated current at either pole. It is in the immediate vicinity of the poles, therefore, that the most direct therapeutic results are obtained, and the readiness with which electrodes may be brought in contact with diseased conditions within the pelvis is a most promising fact for the electro-therapeutics of gynecology, although, even in this class of diseases, the interpolar action of the current must frequently be depended upon.

It is hardly necessary to mention here that no attention is paid to the direction of the current, as such, by modern therapeutists, who look only to the polarity of the active electrode. The older terms "ascending" and "descending" were incorrect in view of the fact that a current spreads in all directions beneath each pole; and the reactions formerly attributed to one or the other direction are now known to be due to the polarity. Even within the interpolar region the direction of the current has no known significance at present.

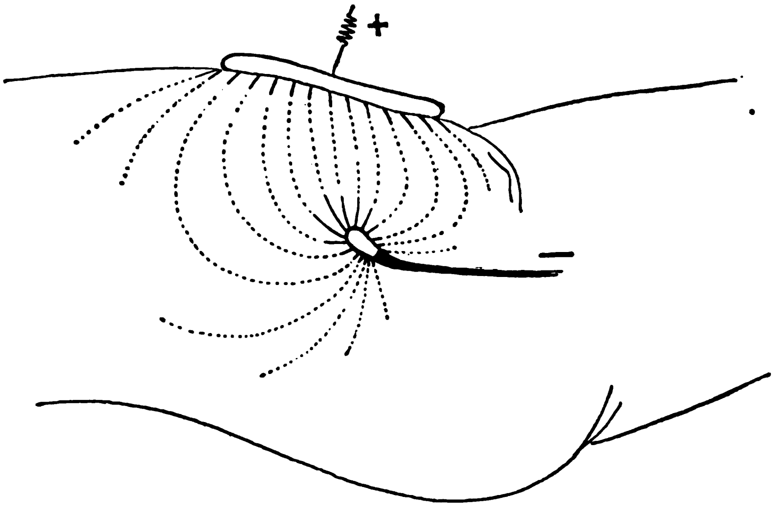


Fig. 25.—Diagram of Polar and Interpolar Regions. The current lines are drawn full in the polar regions and dotted in the interpolar region. The active polar region, which is negative in the cut, extends in all directions around the electrode, but is widest on the aspect nearest to the indifferent pole.

It should also be understood that the region of nerve-polarization about an active pole is somewhat larger than the region of chemic decomposition, and that we can readily include within it any nerve or nerves within, say, three-fourths of an inch of the electrode, when using currents of 20 or 30 milliampères.

The Interpolar Region.—Since it follows, from the facts touched upon in the foregoing paragraphs, that the chemically destructive action of a continuous current is limited to the close neighborhood of the electrodes, and the direct nerve-modifying action is also limited to a somewhat larger region in the same situation, the natural question arises: What can be therapeutically accomplished when the seat of disease is necessarily situated beyond the direct reach of the electrode? An answer drawn from both neurologic and gynecic experience is that much can be accomplished; and this is doubtless due, in the first place, to the influence upon nutrition of the chemic interchanges that occur throughout the circuit, in the onward progress of the electrons that appear free finally at the poles (cataphoresis and anaphoresis), to the influence upon nutrition of the circulatory changes that result from vasomotor stimulation, and to the contractions produced in unstriated muscular tissue by heavy currents, even at a distance.

These results of quiet current transmission are governed in magnitude at a given spot by the *density* of the current at that situation and by the *duration* of the application. The difficulty of carrying an effective density to a tumor, extravasation, or other morbid spot, situated at some distance from the active electrode, is indicated by a glance at Fig. 25, in which the spread of current is well represented by the direction and shading of the lines shown in the interpolar region.

To accomplish much in the more distant parts of this region considerable milliampère-strength must be employed; hence a delicate judgment is demanded in the selection of the size of the active pole to avoid cauterization, on the one hand, and too great a diffusion, on the other.

ELECTROLYSIS.

A current from a battery of cells is an instance of chemic energy converted into electric energy.[1] The correlation of forces in nature is evidenced by the fact that this electric energy may be reconverted into chemic energy when a current is made to traverse a watery solution of salts and other binary compounds, the compounds being decomposed into their ultimate elements by a process called "electrolysis."

---

[1] Which is ultimately true also in dynamo-produced currents, in which the energy may be traced back to the chemic energy of the coal consumed.

All liquids that conduct electricity, except mercury and melted metals, are thus decomposed by its passage through them. To get a clearer idea of what this means, however, we should confine attention to liquids that consist of water, or watery solutions, and the statement remains the same: that, *if they conduct electricity*, they are always decomposed by its passage in exact proportion to the amount and duration of the direct current traversing them. Strange to say, pure water will conduct only an infinitesimal quantity of electricity; to render it a conductor, it is necessary to dissolve at least a minute quantity of some electrolyzable compound in it. That the compound dissolved in it must be an electrolyte to render the solution a conductor is made clearly evident when we attempt to pass a current through a solution of cane-sugar, for instance. No current will flow. Sugar is a nonelectrolyte.

It is evident from these facts that the real conductor in these solutions is the dissolved salts or other electrolytes it contains. The theoretical study of this question has been greatly advanced during the past fifteen years, particularly by Van't Hoff, of the University of Berlin, and by Arrhenius, a Swedish physicist, resulting in entirely new conceptions of electrolysis and its correlative sequences—cataphoresis and anaphoresis—since 1887. The practical aspects of the subject have been even more comprehensively developed in the immense progress made in the manufacture of synthetic compounds and electrolytically separated chemicals in Germany and at Niagara Falls, at the latter place the current from the great power plant being utilized for this purpose.

Now, these newer facts of electro-chemistry teach us that when a salt is in solution in water it is, in a sense, no longer a salt as we know a salt in the dry state, but an ionized solution of the atoms of which it is composed. That is: the molecules of chloride of sodium, for instance, are practically dissociated when in solution in water, the atoms of chlorine and sodium, as well as most of the component atoms of the water molecules themselves, being no longer simple atoms, but, by reason of possessing an electric charge, freely moving electrons. The hydrogen ions of the water and the sodium ions of the chloride of sodium each possess positive charges by the action of the water, while the oxygen ions of the water and the chlorine ions of the chloride of sodium possess negative charges. A pan of water with a little salt dissolved in it is therefore charged with electric potentiality in the sense that each ion has its peculiar charge, ready to do work. Such is clearly the case also in that compound of salts in solution, the human body, with the added fact that in the living condition the ions are already at work in the chemical interchanges that accompany life.

When the terminal electrodes of a battery, or other source of unidirectional electric energy, are inserted within the pan of water, or placed in good contact with the body, the transmission of the current immediately sets the ions in motion, the positively charged ions being propelled toward the cathode and are hence called cations, while the negatively charged ions also seek their opposite pole, the anode, and are hence called anions.

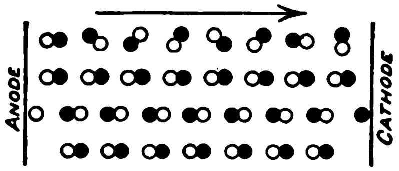


Fig. 26. — Diagram of Electrolysis. The electro-positive radicle, or cation, of each molecule is represented black, and but loosely attached, or probably unattached, to the electro-negative radicle, or anion. Under the influence of the current the cations are propelled to the cathode, where they finally give up their electric charges, becoming ordinary, nascent atoms, with full powers to attack surrounding substances. Under similar current propulsion the anions, shown as light circles, are simultaneously propelled toward the anode, on reaching which they give up their electric charges and are free to manifest their full powers as atoms.

The cut (Fig. 26) illustrates diagrammatically this passage of the cations to the cathode and anions to the anode during the passage of a weak current, the direction of the electric current being shown by the arrow. The lower layers of molecules are shown in a merely dissociated condition, the cations (which are always the hydrogen or bases of the molecule) being shown as dark circles, while the anions (the oxygen and acids of the molecules) are shown as light circles. The uppermost layer shows the ions in motion toward the poles (considering that but a part are in motion with a weak current), the ions continually changing partners with their opposites, or, as Arrhenius shows, even unpartnered, until the cations finally reach the cathode and the anions the anode, where they give up their charges to the electrode and become plain nascent atoms.

At the date of the preceding edition of this work we were still in ignorance of the reason why the dissociated ions did not attack the water or other ingredients of the solution throughout the path between the poles. That they do not is an absolute fact, their true properties as atoms being only manifested when they actually reach their respective poles. An illustration of this inability of an ion of potassium to attack the oxygen of water is shown in the electrolysis of potassium chloride, where the potassium ion fails to attack the water in transit and only acts as an actual atom when it reaches the cathode, when it vigorously attacks the oxygen of the water. The explanation of this is given by Arrhenius, who has proved that *an ion, being an atom charged with electricity, differs fundamentally from the same atom or group of atoms uncharged with electricity, and only resumes its full properties after giving up its charge at the pole.*[1]

It is evident from these facts that, though the ions as they are impelled through the electrolyte may exert profound effects on the metabolic activities of the tissues situated in the interpolar regions, yet the most apparent physical effects are found in what are called the polar regions, or the tissues in immediate contact with the electrodes, where the ions are discharged of their electric charges and appear as nascent atoms, acting upon the surrounding tissues and even the electrodes themselves in accordance with their normal chemical affinities. The polar regions represent the greatest concentration of the lines of flow also, and the site of the greatest physiologic effect. The polar effects are therefore peculiar to each pole and are of predominant therapeutic interest.

Chemic Effects at Each Pole.—Though, as has been said, the electrolysis extends throughout the electrolyte and occurs in any portion of it in proportion to the strength of the lines of flow that traverse that portion, the freed elements appear only at the poles, or electrodes. In the body, constituted so largely of water and various salines in solution, the anions that appear at the positive pole are oxygen, chlorine, and the acids, and the cations at the negative pole are hydrogen and the bases. When released in sufficient quantity the caustic effects are characteristic at each pole, and have been specially applied to therapeutics by Tripier and Apostoli under the name of "galvano-chemic cauterization."

---

[1] "Outlines of Electro-chemistry," by Harry C. Jones. D. Van Nostrand Company, New York, 1901.

Since the gynecic applications of electricity consist frequently of sufficient milliampères and concentration to produce these local effects, their exact nature invites close study. A careful naked-eye observation of the phenomena when a strong current is flowing is certainly both instructive and impressive, as well as decidedly conducive to the future welfare of the observer's patients. An experiment with fresh meat will give a very good illustration of the chemic part of these phenomena as they occur within the living body.

Experiment 1.[1]—Procure a half-pound of beef-muscle; insert into it two ordinary steel needles, one connected with the positive pole and the other with the negative pole of a good battery, and pass through the meat from 100 to 200 milliampères for two minutes.

A sort of hissing or frying noise will be heard. This is seen to be caused by the rapid production and escape of small bubbles (of hydrogen-gas) from the track of the negative needle. The positive needle will cause no appreciable production of gas, but will immediately be found to be so firmly fixed in the tissues as to be withdrawable with difficulty.

On cutting down alongside the negative needle it is found to be practically surrounded by a cavity containing liquids and bubbles of hydrogen-gas. The muscular tissue has been destroyed wherever in contact with the needle, the edges of the cavity showing it softened, infiltrated, and of a darker color. The needle remains as bright as ever.

The positive needle, if left in place and cut down upon, shows itself greatly rusted and corroded, inclosed firmly in a grayish eschar, colored darker in places by the dissolved iron of the needle.

If the positive needle be of brass, copper, nickel, zinc, aluminum, or any of the other baser metals, it is corroded with varying rapidity, the tissues being stained by the particular metallic salts formed for some distance from the needle. On using a platinum needle for the positive pole, on the contrary, it is found to be practically unattacked by the nascent oxygen and acids. The tissues about the needle show now the uncomplicated picture of a positive electrolysis—viz.: the characteristic hardening and searing of an acid application. A slight cavity forms about the needle, though not so large as that about the negative needle, filled with bubbles of oxygen-gas which have failed to unite with the platinum, and the noncorrodible positive needle is therefore not so firmly fixed in the tissues as would happen with a baser metal. This refractoriness of platinum is shared in a lessened degree by gold and carbon, the former being corroded to a slight extent and the latter roughened slightly in time by mechanical disintegration. It is evident, therefore, that, *whenever the active pole of a strong, concentrated direct current is positive, it should consist of either platinum, gold, or carbon, unless we wish to employ cataphoric diffusion of the material of the electrode.*

---

[1] For further experiments with currents see page 351.

The negative needle remains clean, whatever the metal of which it is composed or the strength of the current.

Reverting to the disintegrated cavities in the meat, produced by the negative and positive poles of a strong current (the positive pole having been noncorrodible), we can easily prove that the froth at the negative is alkaline, and that at the positive acid, by placing a drop of litmus solution upon each and allowing the current to continue a few moments. The blue color of the solution is unchanged at the negative pole, but is quickly reddened at the positive. By changing the character of the pole back and forth while still *in situ*, several such changes of color can be produced. The peculiarities of the disintegrating action of each pole are largely due to the nascent alkalies of one and the nascent acids of the other. At the negative pole we have the soft liquefaction and infiltrated edges of an alkaline caustic; at the positive pole the hardened, coagulated eschar of an acid caustic.

Extent of the Destruction at the Poles.—As to the extent of the destruction produced by a current,—a question of great interest in the treatment of tumors and other structures beyond the range of vision,—I have made the rough estimate that 200 milliampères, concentrated at the half-inch exposed end of a negative needle, will destroy an area of this length and a quarter of an inch in diameter in the muscular tissue of the cadaver, if passed through for two minutes. In a living carcinomatous tumor of the breast I have produced a necrotic area about two inches broad by one inch in depth by means of 1000 milliampères of current in ten minutes.

The amount of destruction produced by the same number of milliampères in different tissues varies though, and it may be said to depend largely on the aqueous contents of the tissue, for the cavities produced in the experiments on meat were caused, to a large extent, by the destruction of water. Less decomposition will be attained by the same current in a fibroma than in a striated muscle for this reason, and the disintegration depends more largely on the cauterizing effects of the liberated chemicals, though necrosis does not occur at this pole even with this current-strength if the electrode be of gold freely supplied with a coating of mercury for the oxygen and chlorine to attack.

PHORESIS.

In the exposition of electrolysis just given it will be seen that an essential feature of this process is the passage of the charged atoms, or ions, of the watery solution toward each pole, or electrode, the cations seeking the cathode and the anions the anode. This movement of electrons (or ions) is known as phoresis, the particular movements of the cations being called *cataphoresis* and that of the anions *anaphoresis*. These phenomena are therefore always present in electrolysis, the particular ions appearing at the poles in a given case depending entirely on the substances held in solution in the compound traversed by the current, provided the poles, or electrodes, are incapable of being attacked by the ions after giving up their charges. Should the electrodes be composed of other substances than platinum, carbon, or gold, the electrodes themselves will be attacked by the nascent atoms after their electric charges have been given up, as has been explained. The result of this is *the addition of other and newer substances to the electrolyte,* introducing new problems into the case, with consequences that will depend on the nature of the added chemicals, or whether, in other words, the cathode or the anode is attacked. Since we can diffuse medicinal substances in this way in a variety and to an extent not yet fully comprehended by the medical profession, it has become necessary to distinguish clearly between what is usually referred to as electrolysis, on the one hand, and the phoretic actions, on the other.

Electrolysis, as a medical term, should therefore be restricted to the electro-chemic decomposition of tissues or fluids when both poles, but more particularly the anode, are of unattackable material. In other words, the clinical term electrolysis means the destruction of a part or the whole of a tissue by a constant current *without the addition of extraneous substances from the electrodes or otherwise.*

By the same reasoning, the medical terms cataphoresis and anaphoresis are practically restricted to the *diffusion from without of remedial or sterilizing substances* as cations or anions.

It should be remembered, of course, that any transmission of the constant current through the body in the most ordinary applications involves the physico-chemic phenomena of electrolysis and phoresis within the tissues, but since these applications are purposely not made sufficiently concentrated or strong to destroy tissue, acting generally as a mere stimulant, they are not referred to as electrolytic applications, but as applications of such and such a definite milliampèrage, polarity, and duration of the constant current, the necessary precautions to avoid electrolytic destruction at the electrode contacts being either expressed or understood.

Cataphoresis.—Any substance to be diffused within the tissues by cataphoresis must be such that, when it forms a chemic compound, becomes the electro-positive radical of the compound. These substances are usually termed bases, and commonly represent most metals, except when the metal is united with another metal which is more electro-positive, in which case it becomes the electro-negative ion, or the anion, when it will seek the anode by anaphoresis. An example of the latter condition is iodine, which, being more electronegative than the sodium and potassium of the tissues, is best diffused by anaphoresis from the cathode.

In studying the electro-chemic process by which substances are diffused into the tissues cataphorically we may take the example of copper transmitted through the moist, coagulated albumin of the egg. On inserting two copper wires into a freshly boiled egg and turning on a strong current the following phenomena take place. The saline constituents of the egg are already in an ionized condition because dissolved in water, and both kinds of ions are at once propelled toward the poles to which their electric charges give them an affinity. The hydrogen of the water, the potassium, sodium, and other bases, approach the negative wire; while the oxygen of the water and of the inorganic and organic salts, with chlorine, phosphorus, etc., approach the positive wire.

When the oxygen, chlorine, and other anions reach the positive wire they give up their electric charges, become nascent atoms, attack the copper, and form oxychlorides of this metal, thus producing the greenish-blue discoloration about the pole. As the current continues this discoloration will increase and extend away from the pole.

Now, what has happened to the copper, expressed in the most recent electro-chemic language, is that the affinity between the nascent oxygen and chlorine which caused it to unite with them has made it soluble, or *ionized* it (since, as already stated, all metallic salts are ionized when in solution), thus permitting the now ionized atoms of copper to be propelled through the tissues toward the cathode. It is not necessary to assume that a single anion of the oxygen and chlorine goes back with the copper toward the cathode over the path already traversed by it in the opposite direction. What happens is a continual change of partners between the copper cations and the oxygen anions in their equal progress toward opposite poles. As the copper cations proceed they give their characteristic color to the tissues with which they unite, and, though they are incapable of acting as fully endowed atoms of copper, they do act in the chemic manner peculiar to the particular salt or salts of copper that are formed from time to time.

Besides the phenomena of cataphoresis exhibited in the passage of cations toward the cathode, there is another, purely physical phenomenon involved in cataphoresis apart from the chemic phenomena described. This is electric osmosis, by virtue of which water molecules as a whole pass in the same direction as the cations through an electrolyte. This may be demonstrated in physical apparatus by inserting two electrodes, each of a powerful current, into two porous cups that have been filled to the same height with water[1] and placed in a pan of water of the same depth. After the current has passed for a time it will be noticed that the level of the water in the tube in which the positive pole has been placed is lower, while that in the negative tube is distinctly higher, showing an actual transfer of the liquid.

The same action is easily demonstrated in the living subject during the course of vaginal application, such as will be described later, if the cotton covering of the vaginal electrode is not abundantly saturated with water before insertion. If it is made positive under such circumstances and 50 milliampères turned on, it is extremely probable that the current will shortly decrease on account of actual drying of the layer of cotton in immediate contact with the metal, rendering the resistance greater in that situation. I have seen it decrease to 30 or 20 milliampères in a few minutes, the moisture having been passed onward into the tissues. If now, before actual drying of the cotton has occurred, the current be turned off, the commutator changed to make the internal electrode negative, and the current again turned on, the ease with which the battery will supply 50 milliampères will be in striking contrast to the difficulty when the active electrode was positive. In a few moments the returning moisture of the cotton will admonish us to turn the controller back, or more current will pass through than was desired. The desiccating effect of the positive pole is so great that when concentrated, as in puncture with a fine needle, it is often difficult to get sufficient current without increasing the electromotive force, while no such trouble occurs if the puncture is negative.

---

[1] Ordinary water contains enough impurities to make it a conductor.

This desiccating action of the positive pole renders it of value in lessening congestion and checking hemorrhage, while the congesting effect of the negative pole renders assistance in impaired nutrition, in dilating orifices and canals, and in promoting flow or drainage.

It has been seen that the metal of which the positive pole is composed is a matter of importance, since, if not platinum or carbon, it is attacked by the nascent anions released in contact with it, particularly oxygen and chlorine. Iron, lead, zinc, brass, and copper are easily and deeply corroded in this way; tin, silver, and aluminum less readily, yet distinctly, acted upon; and even gold is roughened and its alloys oxidized after a time. Carbon resists any direct action apparently, yet a carbon electrode in continual use as a positive pole soon becomes roughened, apparently by a detachment of the looser particles on its surface, but possibly by the direct action of the oxygen. Platinum alone, and its more rigid alloy with iridium, seems to be the only metal absolutely proof against the intense chemic activities concentrated at the positive pole of a strong current.

Platinum and carbon anodes therefore enable us to produce, when the current is strong and concentrated, a caustic action due to nascent oxygen and chlorine alone, while the baser metallic anodes add the effect due to caustic salts of the metal employed, and their use also involves a cataphoric transmission of the metal into the body if no electrode covering is used. With or without an electrode covering, and whether concentated or dispersed by varied sizes of electrodes, an amount of metal is always dissolved from the anode, or positive pole, of a base metal in exact proportion to the millicoulombs used.

Besides the depleting and congesting actions of the two poles already alluded to, it will be seen, therefore, that important use may be made of metallic cataphoresis, if desired, by using the metal as an uncovered anode. This subject has been elaborated by Gautier, Morton, Goelet, and Cleaves, and, in addition to the following description of the *modus operandi*, its application in special classes of cases will be dwelt upon in the chapters devoted to special therapeutics, particularly in the description of the author's new method for the treatment of cancer.

Mercuric Cataphoresis.—The cataphoric administration of mercury, which, so far as the author is aware, is original with him, is accomplished by amalgamating gold electrodes with this metal (*i.e.*, causing the mercury to adhere to the electrode surface by first dipping the latter into weak acid and then into mercury). When employed as a positive pole, the mercury disappears from the gold by becoming ionized, as described above, and is diffused in a radiating manner from the gold electrode toward the opposite pole, along the lines of current-flow, producing a dark-lead-colored stain in the tissues. If the current be strong and its duration sufficient, the gold will be finally bared of the mercury (and also of its alloys if used for the first time). Before each subsequent application the mercury should be renewed, though a second application of acid may not be necessary.

The immense value of a process that enables us to diffuse mercury in atomic proportions directly into a diseased tissue is evident when we recall the well-known qualities of the metal when administered by the mouth, and realize that we have the additional advantage in this process of dealing with nascent salts of the metal,—a condition of chemic compounds in which their strongest qualities are evinced.

It is my belief, supported by facts detailed elsewhere, that this method will be of immense value in adding to the sorbefacient and alterative actions of electricity in chronic inflammatory conditions and their sequels, and, more important still, that in the massive infiltration of neoplasms, even of cancerous character, by the oxychlorides of lethal metals, we have the best method extant of destroying the essential principle on which their malignancy depends (see page 205).

An incidental advantage in employing mercuric cataphoresis instead of simple positive galvano-chemic cauterization in many intrauterine applications is that the effect is less caustic, while probably of greater benefit, for the nascent oxygen and chlorine expend their energy on the mercury instead of on the surrounding flesh.

Anaphoresis.—Anaphoresis is, of course, the diffusion within the body of substances that become anions when ionized by solution in water. But little study has been made of this department of phoresis by physicians, and it may be said that electro-chemists, indeed, need to determine the practical phoretic direction of many substances which are yet undetermined. The only substance of practical importance to the physician which has been positively determined to be anaphoretic, so far as known at present to the writer, is iodine, which should always be diffused from the negative pole, preferably in solution with iodide of sodium or potassium.

General Medicamental Phoresis.—The possibilities of the phoretic method of administering remedial agents are very great and but slightly realized at present by the profession. Its chief value, of course, is either when we wish to administer the remedy to a certain locality accessible to, or in the near neighborhood of, an electrode, without diffusing it throughout the system, or when we wish to overwhelm a certain locality with the remedy in its nascent condition.

All active principles of medicines are capable of being so administered, the amount transmitted into the body being directly governed by the millicoulombs of current (see page 322), but it is important to carefully select the pole on which to place the remedy in accordance with its chemic nature. This is readily determined of those substances whose constitution we know, remembering that there is a double action going on: (1) a simple electric osmosis, always from the positive pole, by which the water in which the salts are dissolved is transmitted inward toward the negative pole; and (2) an electrolytic double current, in which the molecules of the compounds are broken up into their constituent atoms, the oxygen and acids going from the negative to the positive, and hydrogen, alkalies, and the bases going from the positive to the negative. This, of course, means that such substances as hydrochlorate of cocaine and the salts of other alkaloids should be placed on the positive pole, the active base being driven inward toward the negative pole and the useless hydrochloric acid adhering to the positive electrode. Conversely, if we wish to administer the arsenic in arsenite of potassium or the iodine in an iodide we recall that the arsenic and iodine are the active agents, and that, being the anions of the compound, they are propelled from the negative pole to the positive one; the solution should therefore be placed at the negative pole.

Phoretic Speed of Ions.—Kohlrausch discovered that each atom has its own rate of motion in a given liquid, independently of what it may happen to have been combined with, hydrogen atoms traveling faster than any other atoms. Lodge[1] gives the subjoined table of the speed of atoms of the substances mentioned when urged by a potential of 1 volt per lineal centimeter of electrolyte. The speed of some chemical substances of interest in this connection is unfortunately not included.

TABLE OF PHORETIC SPEED OF IONS AT ONE VOLT PER CENTIMETER.

Hydrogen	1.080	centimeters	per hour.
Sodium	0.926	centimeter	per hour.
Iodine	0.216	“	“
Carbon	0.213	“	“
Potassium	0.205	“	“
Silver	0.166	“	“
Lithium	0.094	“	“

Temperature Effects. — The electro-chemic actions involved in electrolysis and phoresis in the human tissues when a constant current is passed through them necessarily involve a rise of temperature in the polar regions, where the ions give up their electric charges and exert chemical action. This rise of temperature may be due to the chemic action alone, when it is not considerable even with heavy currents, but is mainly due to the *transformation of electric force into heat as a result of encountering resistance,* when heavy currents are concentrated at small electrode contacts, as when over 250 milliampères is concentrated at one small active pole in the destruction of cancerous growths within cavities by zinc-mercury cataphoresis. When over 250 milliampères is so employed the increased heat at the site of application becomes so great in a few minutes as to necessitate a cooling stream of water every five or ten minutes, in order that the cataphoresis may not be arrested and turned into a mere heat action by excessive drying of the tissues.

In ordinary work with smaller current strengths this rise of temperature is too slight to be detected.

---

[1] "Modern Views of Electricity," Lodge, p. 87.

GENERAL PHYSIOLOGIC ACTION OF CONSTANT CURRENTS.

Functional Stimulation and Sedation due to Polarization.—*(a) Indirect Stimulation and Sedation Through the Medium of Nerve-trunks.*—In addition to electrolysis and phoresis, which are effects practically obtainable only from direct or constant currents of appreciable milliampèrage, there remains to be considered another mode by which electricity may act upon the body, which may be called "functional stimulation," or "sedation" as a result of tissue polarization.

In its indirect form, or the stimulation of organs through their afferent nerve-trunks, this mode of action has been the one most generally recognized in electro-therapeutics, many neurologists practically regarding it as the only action, though in real importance it is often overshadowed by electrolysis and cataphoresis. Closely connected with current volume and concentration, and, hence, peculiarly displayed by constant currents, it is, by virtue of its appearance at the instant of variation in slight currents of higher voltage, the only appreciable mode of action of magnetic induction and static currents.

When the special functions are indirectly stimulated through the nerves, both motor and sensory, the response, even with direct currents, is limited mainly to the moment at which the variation occurs in the electric condition of the nerve. The functional stimulation thus produced occurs at increase or decrease of current at either pole, the response being proportional to the amount of variation and to its suddenness; in other words, an increased speed of variation will compensate for less current, and *vice versa.* For speed of variation we may substitute height of pressure (which has been defined by some as synonymous with velocity), for it is also true that, the greater the pressure, the less the milliampèrage required to stimulate. An illustration of this may be found in the fact that the static induced current with several thousands of volts' pressure and less than the thousandth part of a milliampère of volume will contract a superficial muscle better than an insufficient dose of a direct current, even though it be several milliampères. Though with weak currents nerve-stimulation is thus limited to the moment of varying, closing, or opening of the circuit, with strong currents the stimulation or sedation continues throughout the duration of the application, producing a continuous contraction or sensation. All current variations are stimulant, though the constant current is sedative at the positive pole, and very rapidly successive induced currents of high voltage and minute ampèrage will act as an analgesic.

This excitation of function is supposed to be due to the sudden polarization or depolarization of the nervous molecules traversed by the current. It is always greatest when the nerve is under a concentrating electrode, and the action at each pole of the constant current differs in relative vigor, due to the fact that a condition of stimulation occurs at the negative pole, or cathode, called "catelectrotonus," and one of sedation at the positive pole, or anode, called "anelectrotonus." These differences are of great value in pelvic applications and also give rise to the formulas of motor response so important in neurologic diagnosis.

Catelectrotonus.—If a nerve be subjected for a few moments to the action of the negative pole of a constant current placed in its immediate neighborhood, it has been demonstrated that its excitability to all stimuli is distinctly increased. This has not been adequately explained, but it is possible that the influx of fluids into the nerve due to cataphoric action is the chief cause.

Anelectrotonus.—A nerve similarly placed with respect to the positive pole has its irritability decreased. The desiccating effect of this pole would seem to explain this also.[1]

(b) Direct Organic Stimulation and Sedation.—The stimulating and sedative effects of the constant current are by no means confined to the intermediate agency of the nerves. Muscular tissue of both the voluntary and involuntary kind itself responds to milliampère currents, and, though the demonstration of direct cellular stimulation is not so easy in other organs of the body, it is extremely probable that glandular and secretory organs and the general tissues of the body have a response to the continuous current independently of their innervating and trophic nerves, similar in kind to the skin responses (blanching and reddening) that are so readily observed by the eye. It is, particularly, this general tissue-stimulation that renders

---

[1] The chief factors in the normal formula of motor nerve responses are the facts that the first response with a weak current appears at the production of catelectrotonus, or cathodic closure (closure of circuit with negative pole over nerve), and the next, with an increasing current strength, at the return of a relatively cathodic condition (equal to disappearance of anelectrotonus) at anodic opening; hence the formula: K. Cl. C.⁗, O. C.‴, A. Cl. C.″, K. O. C.′

constant current applications of greater value in gynecology than if they depended on muscular and nerve effects only, for we thus influence the multiform processes of tissue-metabolism, lymphatic activity, and nutritive repair, that are so important in correcting the conditions that are found in the pelvis after many acute or chronic inflammatory processes.

Bactericidal Action of Electricity.—The influence of the constant current on the vitality of microbes has been investigated by Schiel, Cohn, and Mendelssohn, and more recently and thoroughly by Apostoli and Laguerrière.[1] The latter observers made a most thorough study of the subject during a series of fifty-two experiments on the microbes of anthrax, pus, and various nonpathogenic varieties, in which 140 guinea-pigs, 42 rabbits, and 2 dogs were killed.

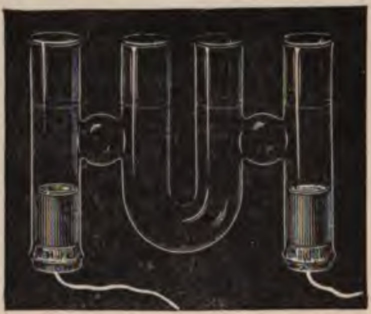


Fig. 27.—Apparatus Employed by Apostoli for Testing the Bactericidal Action of Electricity.

The apparatus found best adapted to the determination of the action of each pole is shown in Fig. 27, by the use of which it was possible not only to isolate the action of each pole in its tube, but also to test the interpolar effect adjacent to each pole. As was to be expected, the passage of strong currents from the surface of small platinum spirals through the peptonized broth used caused a decided rise of temperature, particularly at the positive pole. In some of the experiments this thermal influence was eliminated by placing the apparatus on ice. In others the chemicals liberated at each pole were eliminated, either by the use of an absorbent, such as magnesium or lead, at the positive pole, or by being covered with a vegetable mucilaginous material called gelosin. The results showed a distinct attenuation or destruction of the microbes when currents of more than 50 milliampères were used for five minutes. Beneath that dosage the action of the positive pole actually increased the virulence of the microbes, doubtless by reason of the addition of free oxygen to the media and a moderate increase of temperature. It was further proven that neither the negative pole nor the transmitted current through the interpolar region exerted any influence on the vigor of cultures, and that the action of the positive pole was entirely dependent on the nascent chemic products and the heat that were developed.

---

[1] "De l'Influence du Courant Continu sur les Microbes." Par MM. Apostoli et Laguerrière. Reprint, Paris, 1891.

These carefully conducted experiments must certainly discourage the use of constant current applications as germicides, *per se*, within the body-cavities,[1] since current-strengths entirely sufficient to cure certain postinfective cases do not develop that quality; but in this disappointment we only follow the experience of antiseptic therapeutics as a whole in these cases. They prove, nevertheless, that, where currents exceeding 50 milliampères, concentrated, are called for in their curative capacity, we may also anticipate a direct microbicidal action accompanying them. It need not be said that this is a great comfort in electro-surgery, and that in the ampèrages used in cancer, for instance (from 400 to 1000 milliampères), we also employ a most efficient and thorough antiseptic application. For antiseptic action in currents under 50 milliampères we must rely upon antiseptic cataphoresis, in which it is possible that minute currents may be made efficient by surrounding the active pole with a cotton covering holding antiseptic solutions, or by using an amalgamated anode.

The Alterative Action of Electricity.—Whatever conclusions are arrived at relative to the bactericidal action of electricity, it should not be forgotten that the cure of the latter stages of affections of bacterial origin necessitates an alteration of abnormal nutritive processes which have resulted from the bacterio-phagocytic contest. Nature must be stimulated and assisted in the removal of this proliferated material; hence the administration of electricity for quickening cellular metabolism should be arranged for in such cases. The negative pole of the constant current is indicated for this purpose in gynecology, while the various static and high frequency modalities are also useful in general conditions.

---

[1] Except in connection with mercuric or other antiseptic cataphoresis, which acts freely and immediately, one application sufficing to asepticize the worst ulcer.

Indications for Choice of Poles.—The determination of which constant current pole to use in gynecic practice will be specially considered in connection with each affection, but it is rare that the result of experience contravenes certain guiding principles derived from the facts contained in the foregoing paragraphs. From them it is apparent that the reasons governing choice are chemic, phoretic, and electrotonic. The positive pole is therefore microbicidal, capable of diffusing medicaments, drying, depleting, hemostatic, and sedative. The negative pole is congesting and therefore a quickener of absorption, increases moisture and drainage, dilates canals, produces most destruction in electrolytic concentration, and is most stimulant.

Interrupted Direct Currents in Gynecology.—Interruptions of the direct, or constant, current, either rapidly or slowly produced, are rarely, if ever, used in direct pelvic applications, for the reason that they are far more productive of pain and shock than induction currents and are in no wise more effective than the latter.[1] The avoidance of sudden current variation, indeed, is a most important detail in the majority of applications of this sort, and it is for this reason that the author has advised the gradually increasing and decreasing method in this work.

Differences Between the Currents Used in Medicine.—What has been considered in the preceding pages as the constant, or direct, current is the medical designation of the simple, unidirectional current of electric energy, which would require no special designation were it not that we use other forms of electric currents in medicine that differ greatly in qualities and effects. The constant, induction, and static currents are widely different remedies in practice, though they are all electric currents and convertible into each other by varying the mode of construction or operation of the generators that produce them; that is, it is possible to do so, though usually inconvenient. The Edison current-dynamo is, however, practically an induction machine so constructed as to give a constant current.

---

[1] This statement by no means applies to the neurologic applications of electric currents.

The real differences in these currents depend on the proportions of pressure and volume possessed, and whether they are direct or alternating, continuously flowing or a discontinuous series of inductions. Constant currents used in medicine have a pressure varying from a few volts when a few cells are used to 100 or 110 volts or more, and a volume varying from 1 to 500 milliampères or more, and are direct and continuous unless specially interrupted. Magnetic induction and sinusoidal currents are said to have a pressure of about 100 to 300 volts, according to the coil and core used, and a volume of a small fraction of a milliampère (probably from $^1/_{10}$ to $^1/_{1000}$ milliampère). They are discontinuous and usually alternating, and each current-throb is of extremely short duration. Static and high-frequency currents have a pressure of 60,000 volts or more, but the volume is usually below $^1/_2$ milliampère.

CHAPTER V.

TYPICAL METHODS OF APPLYING ELECTRIC CURRENTS IN THE DISEASES OF WOMEN.

WHATEVER form of apparatus is selected for the application of electricity in both the medical and surgical diseases of women, it should invariably include a controller through which both the induced and constant currents must pass before reaching the patient, since none of these applications necessitate the use of shocks of any kind, and sudden accidental variations of the current should be rendered impossible. It must also invariably include a reliable meter through which the constant current must always pass while traversing the patient.

It is well to fix upon some definite relative arrangement of the operating-chair or couch and the apparatus. The author, having educated the left index finger for the gynecic touch in the early years of his practice, at the suggestion of the late Dr. Goodell, employs this hand particularly for the examinations and the manipulation of electrodes, leaving the right hand for the management of the controller, switches, etc. The relative arrangement of the chair or couch when the work of each hand is similarly determined is shown in Plates I and II.

The chair or table should be used in making diagnostic examinations and in all intra-uterine applications. The couch is essential in general, spinal, and most other applications, and may be used for vaginal applications, at times, by the acquirement of special skill.

The typical methods of applying electricity in both general and local affections of women may be described as follows, with the preliminary statement that the electrodes are invariably placed in position before the current is turned on, the controller handle being carefully placed at zero, or the starting-point, and that the current is turned off before the electrodes are removed, avoiding shocks of every kind.

General Direct Current Stimulation.—In the application of this method the patient disrobes and lies on a couch on which a sheet or blanket has been so placed that both ends can be folded over the

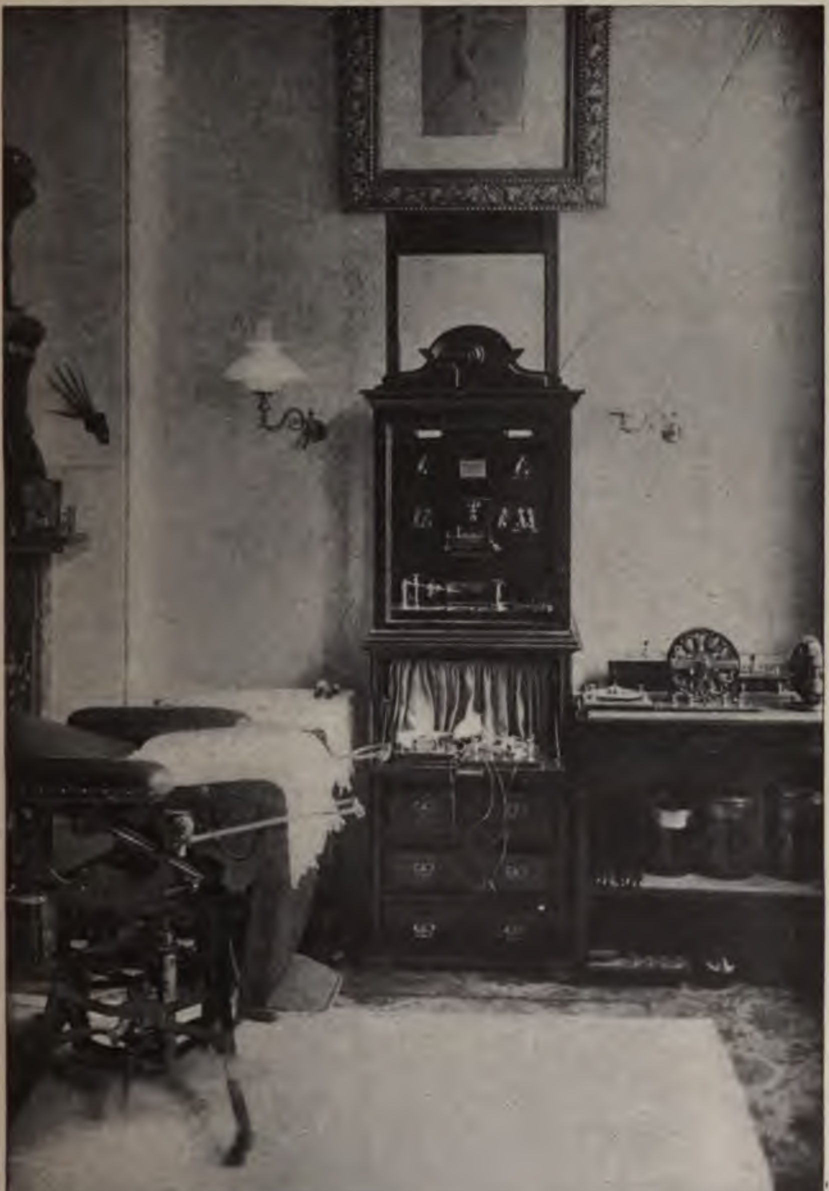


PLATE I.—Arrangement of Examining Chair and Apparatus.

person. On this and beneath the back a large dispersing electrode is placed (page 349), connected with the positive pole of a constant current. To the negative cord is attached a round active pad, moist and well soaped, preferably with "Ivory" soap. Beginning with the arm (Plate III), the pad is held in contact with it and the current turned on at the controller, after which the pad is passed up and down over the nerve-points of each group of muscles, taking care to act only on groups associated in action at one time. For instance, all the extensors of the hand can be easily moved by stroking the anterior aspect of the forearm, and the flexors by stroking the posterior. The pad is slipped from one side to another without breaking contact, and the whole arm can thus be successively thrown into action without turning the current off. On finishing the arm at the shoulder the current is turned off, the pad removed, and the skin freed from soap and dried.

The same procedures are repeated with the other arm and each leg (Plate IV), after which the pad, freshly moistened and soaped, is applied to the abdomen, and circular movements made in the direction of the colon (Plate V). It is often wise to apply a primary induced current in this exact manner, through the controller, to the abdominal organs either before or after the direct current application to the same parts (Plate VI).

The patient may then turn over, with the indifferent pad under the abdomen, and the direct current is applied to the back and flanks with slow up-and-down movements (Plate VII).

The current strengths employed in this method vary with the part of the body and the amount of adipose tissue covering the nerve-points. fleshy persons requiring more current. Usually from 15 to 20 milliampères will do for the arms, 30 to 35 for the legs and thighs, and from 50 to 100 for the abdomen and back. The nerve-points for motor stimulation of value in these applications are shown in Plates VIII and IX.

This application is probably the most powerful stimulus to be found in general electric applications. In weak and nervous people it is apt to be followed by a short period of vascular depression and cold extremities preceding the reaction, but as strength is gained the warm reaction is more immediately realized. The method will usually be found to be perferable to induction currents in the class of cases usually placed on the rest cure, and may also be used alone in cases of neurasthenia which are not suitable for, or will not submit to, isolation and rest, the strong currents transmitted through the abdominal viscera being particularly valuable in arousing dormant abdominal nervous forces so commonly deranged in these cases.

General Induction Current Stimulation. — The patient being placed as described in previous paragraphs, the coil to be used selected and put into operation and the large pad adjusted to the back, the applications are made to the limbs and abdomen in the same manner as with the constant current, the controller being used to regulate the current strength to the amount required to contract the several groups of muscles. As with the constant current, it is not wise to use more than needed to obtain a full motor response, since additional current will only give unnecessary pain. This monopolar method is quite essential to a proper induction current stimulation of the abdomen, but in the case of the limbs the Duchenne, or bipolar, method is somewhat preferable at times, producing a more local contraction of each group. In this bipolar method the two ordinary disk electrodes may be held in the same hand, the negative applied to the nerve-point and the positive near it on the belly of the muscle.

Abdomino-dorsal Applications.—The patient lies on the back as in the preceding applications, with a large pad under the dorsal or lumbar regions, the clothing being removed from the field of application and protected from wetting by folded towels. Making sure that all current is turned off at the controller, the active electrode, the medium-sized round cotton pad, well moistened and soaped, is next placed on the abdominal surface. The current, whether constant, induction, sinusoidal, or combined, is then turned on until the desired strength is obtained and the pad slid around in the direction of the colon.

The large electrodes and the perfect contact assured by the soapy lather enable a considerable density of current to be carried into the abdomen, since we can readily use from 60 to 100 milliampères, and it is not only an effective way of impressing the nerve and muscular structures of the pelvis and abdomen, but, by an upward extension of the field, we are enabled to act favorably on the stomach, liver, and possibly other digestive organs.

Spinal Applications.—The transmission of continuous currents through the spinal cord, so useful in many neuroses in which symptoms referred to the spinal region exist, is also of signal value in the

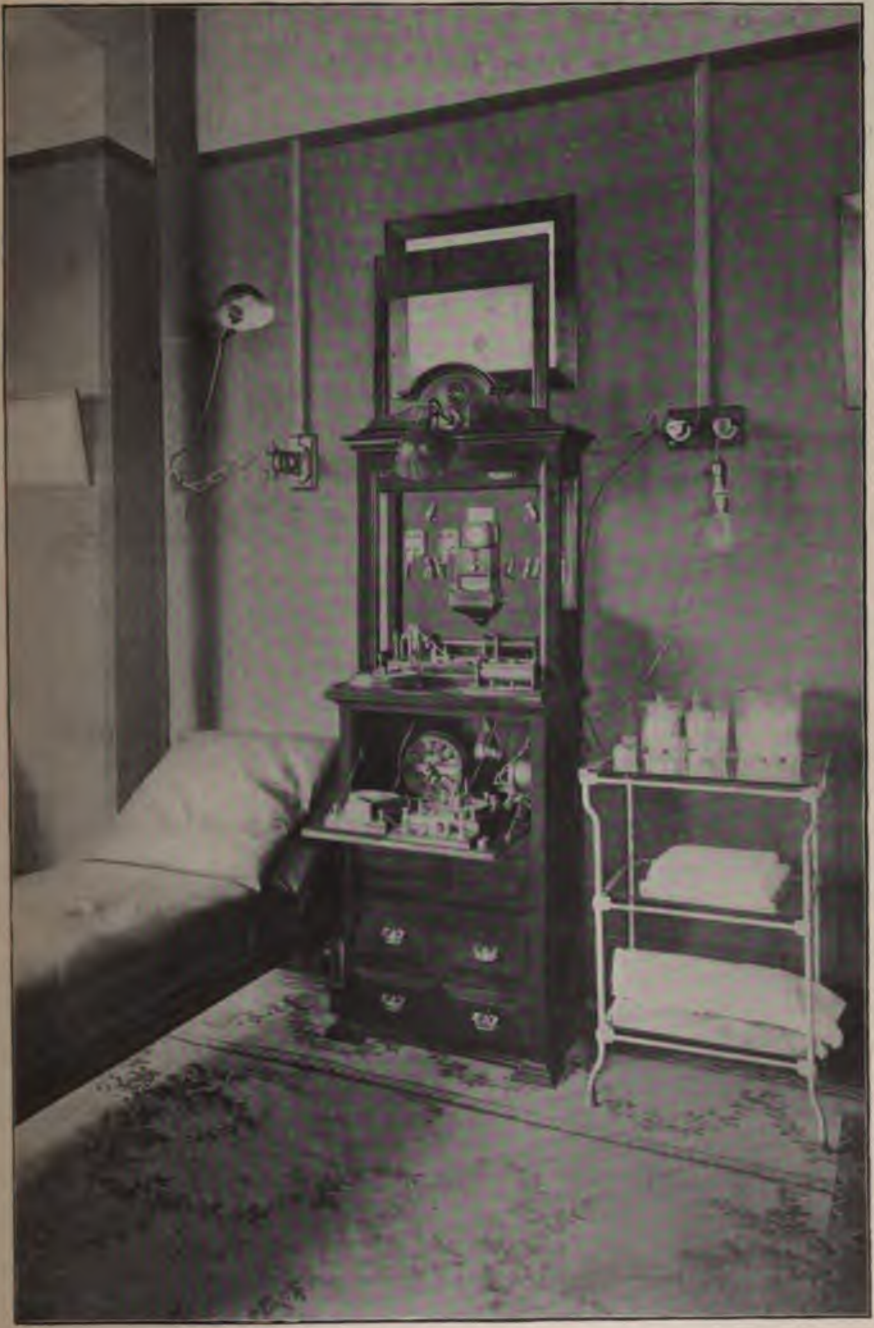


PLATE II.—Arrangement of Applying Couch and Apparatus.

amenorrhea and dysmenorrhea of young girls, requiring no concurrent medication if anemia does not co-exist. The patient sits sideways in a chair with the clothing loosened at the back, and two spinal electrodes are used (about two and a half by five inches), the positive being placed immovably on the lumbar region, and the negative held in contact with the cervical and various parts of the median and dorsal regions, in turn, giving a *stabile,* or stationary, current in each region of a minute's duration. From 10 to 70 milliampères may be used, in accordance with the patient's endurance. The induction current is not used in this manner, as it would doubtless fail to act on the cord or deep-seated nerve-roots.

A more effective application than this is simply the reverse of the abdomino-dorsal application, the patient lying face downward with a large pad under the abdomen (Plate VII). The round pad is thoroughly soaped and passed up and down the back, employing 20 to 40 milliampères on the cervical and upper dorsal regions and 40 to 60 on the lower dorsal and lumbar regions; these figures may all be greatly exceeded in proper cases.

Vaginal Constant Current Applications.—All the constant current applications usually made to the vagina are for the purpose of bringing organs situated beyond it or the general pelvic contents under an interpolar influence (page 45). They are all necessarily monopolar therefore, one electrode, the active pole, being within the vagina and the inactive pole, in the shape of a large pad, either on the abdominal surface or beneath the back. If the active electrode can be pressed behind the exudation or enlarged organ, as is usually the case, the indifferent pad may be on the abdomen, otherwise it should be on the back, these dispositions of the electrodes being best designed to include the seat of disease within the tract of densest current-lines between the electrodes (see "Current-diffusion," page 40).

Contrary to the conclusions expressed in some previous editions of this work, it should be said that the conducting surfaces of all vaginal electrodes used with the constant current should be properly covered to protect the vaginal mucous membrane from irritation, particularly if the positive pole is used, and irrespective of the metal of which the electrode is made, unless the vaginal mercuric cataphoresis method, described at page 135, is used. This rule applies more generally to vaginal applications than to uterine, because it is not usually the case that the vaginal application is designed for the vagina itself, but for the structures beyond, the covering permitting more current to be used without cauterization (page 38). The relatively large size of a bare vaginal electrode lessens this cauterization itself, as was stated in previous editions, but does not entirely obviate it.

A large experience in this form of application has convinced the author that the best and most convenient covering for this electrode is absorbent cotton wrapped about the conducting surface until a ball of proper shape and size is obtained, the covered electrode being then dipped in warm water until thoroughly soaked and then lubricated with a nonirritant soap. The cotton is, of course, detached and thrown away after each application, permitting the electrode (Fig. 28) to be thoroughly cleansed and asepticized. Dr. Goelet has introduced a clay-ball electrode designed to secure a contact-surface of clay within the vagina, but the author can see no advantage in the use of this substance to compensate for its inconvenience as compared with thoroughly moistened and soaped absorbent cotton.

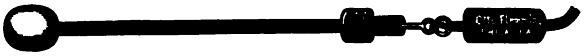


Fig. 28.—The Massey Vaginal Electrode for Mercuric Cataphoresis. The bulb is of brass and measures $^7/_8$ by 1 $^1/_8$ inches, and should be freshly amalgamated with mercury before each application. The hard rubber cover to the stem, furnished by the manufacturer, may be discarded and the fused wax recommended by the author used instead. The handle has a shield to protect the thighs from accidental contact with the tip of the electrode.[1]

The soaped electrode may be easily inserted without the use of a speculum, the patient being usually in the dorsal gynecic position. If the seat of mischief is mainly in the posterior *cul-de-sac,* it is inserted there, tilted forward somewhat, away from the rectal nerves; if in the right or left ovarian region, it is placed in the right or left fornix. The indifferent pad may be the round pad described on page 349, the large cotton pad, or the Apostoli clay pad.

The active electrode is not inserted until the battery is found

---

[1] The larger sized zinc mercury electrodes shown in Figs. 33 and 34 may also be used for this purpose.

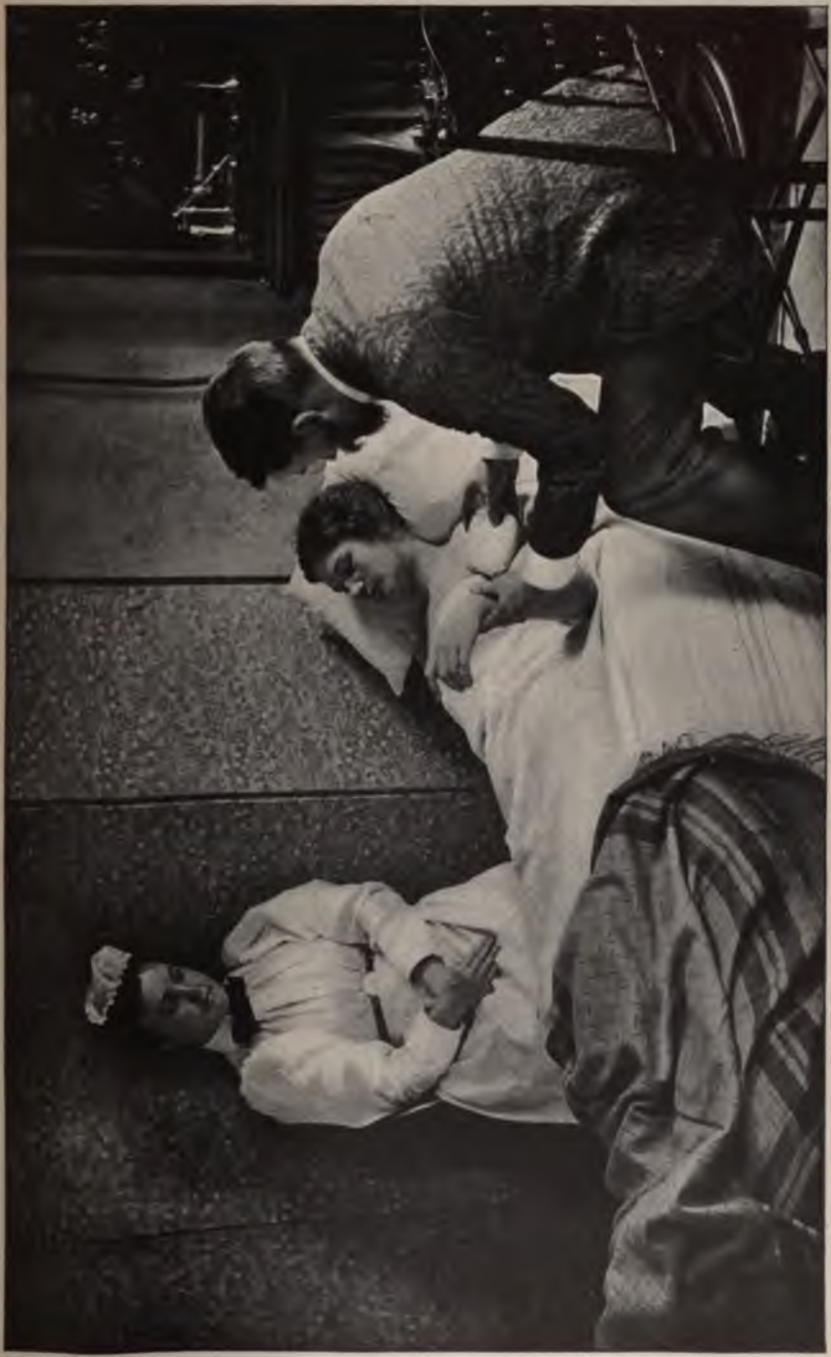


PLATE III.—Application to Arm, General Direct Current Stimulation. (From Photograph of Model.)

to be in readiness, the indifferent pad adjusted, and a glance at the connections and controller shows the latter to be resting at the starting-point.

The duration of a vaginal constant current application may vary from five to ten minutes, rarely longer with strong currents if the application be made daily. It should be repeated at least thrice weekly. The current strength used by the author varies from 40 to 150 milliampères, being usually about 50.

The choice of pole is not a matter of indifference, proving that the application is not altogether interpolar, as clinical experience shows a distinct advantage in the use of the positive pole in conditions of pelvic inflammation or exudation approaching acuteness, while the negative pole causes greater congestion and quickening of the absorptive processes.

Vaginal Induction Current Applications.—*(a) Monopolar.*—The technique of monopolar induction current applications to the vagina is exactly similar to the constant current application just described, except that the electrode surface may be smaller and may be either covered or bare as most convenient, the natural moisture of the vagina being sufficient for the conducting joint between the electrode and the mucous membrane. Much has been written concerning the advantages of certain positions of the internal electrode, a subject that will be discussed in connection with the treatment of displacements. If the purpose of the application is the cure of relaxation of the muscular structures, including the uterus, the primary current turned on through the controller should be used, of a strength short of the production of pain. If, on the contrary, the purpose be to overcome pain, whether due to congestion or to neuralgic conditions, the secondary is best.

(b) Bipolar.—Under the lead of Tripier and Apostoli much attention has been directed to the employment of bipolar induction applications to both the vagina and uterus, Tripier having been chiefly interested in developing the value of the current of quantity and Apostoli that of a high electromotive force (page 365). There are no clear relative indications governing a choice between the monopolar and bipolar applications, some physicians resorting almost exclusively to one method and some to the other; but it is clear to the author that the bipolar method is always most effective in the control of pain.

For this purpose the longest and finest wire is usually preferable, even if the patient asserts that she feels nothing. I say usually preferable, for the control of pelvic pain by the use of high-pressure currents is yet an empirical study, albeit in the main successful, for we must meet the varying conditions therapeutically on which pain depends. It has appeared to the writer that, when the pain is due to relaxation of the muscular parts, a bipolar application of a moderately contractile current, such as that from the medium length coil, is best, and this is, perhaps, due to the current setting in motion waves of contraction in unstriated muscular fibers, resulting in added tone. When the pain is more truly neuralgic in character, on the other hand, the mere analgesic effects of the longest coils of No. 36 wire are best.

When the electrode has been inserted and the current turned on at the controller the electrode should be held immovably in place, as any movement during the application will be a disturbance of the effect. Dr. Goelet's modification of Apostoli's instrument (Fig. 29) has distinct advantages in the ease with which immobility is maintained after placement, as it is lighter in the handle, and by its shape is in some cases self-retaining. The whole current from the coil used can generally be employed, and the duration of the application may be from four to ten minutes or longer. It should be administered daily if practicable.

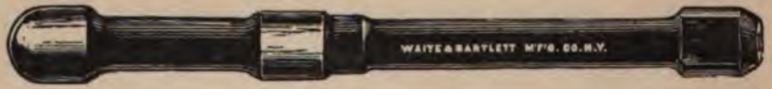


Fig. 29.—Goelet's Bipolar Vaginal Electrode.

Intra-uterine Constant Current Applications.—Apostoli, to whose labors are due the establishment of monopolar intra-uterine applications of the constant current as a scientific procedure, invariably designated them "galvano-chemic cauterizations." Such they always are if the active electrode is bare and the current sufficient to cauterize when so concentrated; but if the conducting surface of the intra-uterine electrode is covered with moist cotton, as is frequently done by the author, a modified cauterization will result, unless the current be very strong or its duration prolonged. A distinction should there-

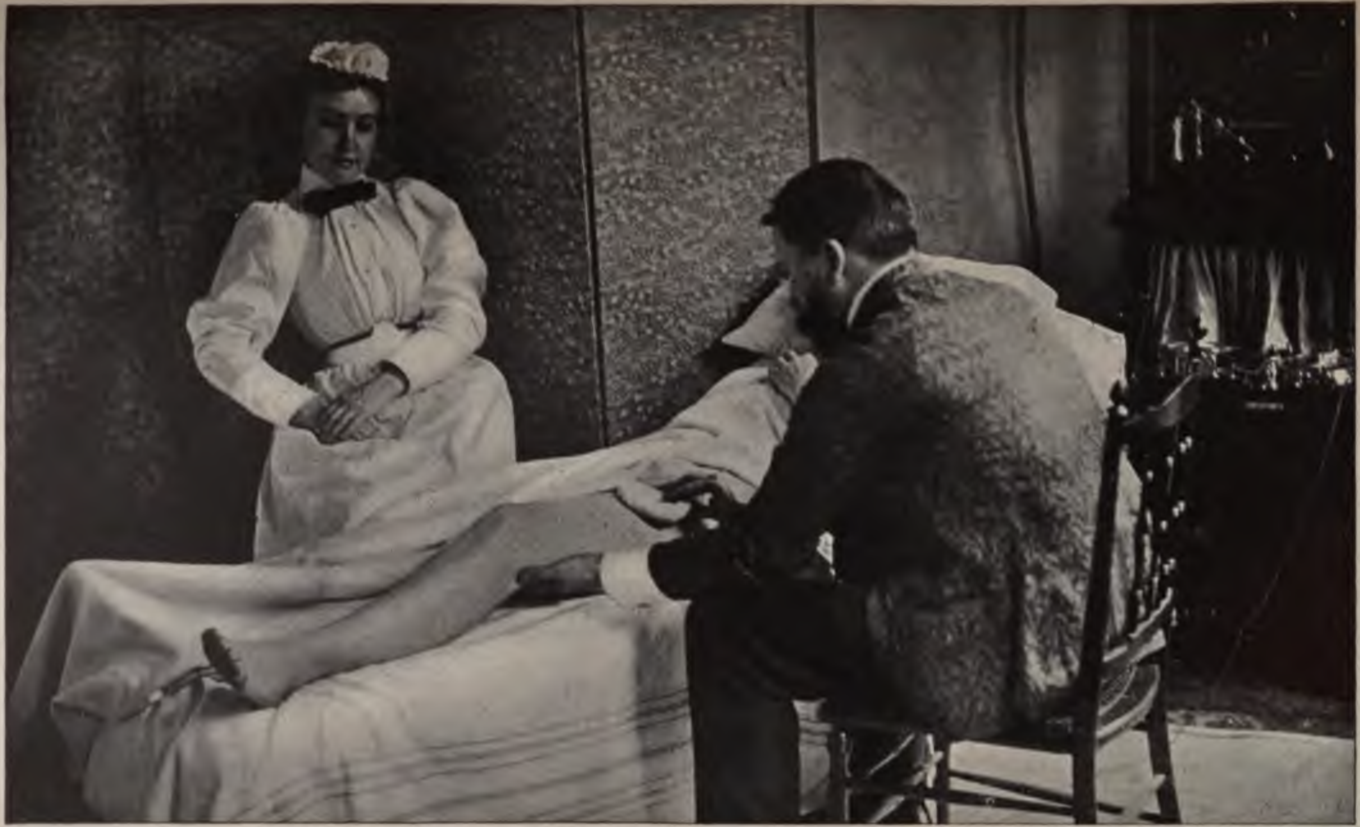


PLATE IV.—Application to Leg, General Direct Current Stimulation. (From Photograph of Model.)

fore be considered to exist between a mere constant current application and a galvano-chemic cauterization.

A most marked difference exists in the nature of these applications in accordance with the pole employed, as fully described at page 48. If simple positive cauterization is required, it is essential that the exposed surface of the active electrode should be either of platinum or carbon. Should any decomposable metal—such as copper, silver, zinc, or iron—be employed at the positive pole, a cataphoric application results, adding important features to the results, which may be advantageous or detrimental, according to circumstances (page 49). When the active electrode is negative, it does not matter of what the electrode is composed.

Instruments.—For the intra-uterine electrode Apostoli and some operators in this country use a sound capable of being covered at will by a sheath, made of either glass or hard rubber, or, as specially commended by the former, of celluloid, which is said to be less absorbent than the rubber (Fig. 30). These sheaths are extended backward into handles, through the whole of which the sound slides, and to which it may be rigidly connected at will by a screw. In my own practice I have found that this arrangement presented certain disadvantages. It is difficult to render the interior of the tube aseptic, and the best antiseptic—the flame of an alcohol-lamp or Bunsen burner—cannot be applied to the exterior of the rubber and celluloid sheaths, owing to their inflammable nature. In most cases, moreover, the insulating cover should be extended beyond the bend of the sound, in order that the cervix may be protected from unnecessary cauterization and the current action confined to the interior of the corpus alone. This is impossible if the sheath is made of a rigid material, and, were it possible, the abrupt increase of caliber at the end of the cover would render the proper introduction of the sound impossible in many cases.

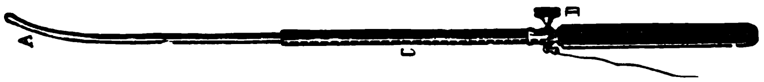


Fig. 30.—Apostoli's Intra-uterine Electrode. The electrode *(A)* slides in the handle *(D)* and is of platinum. At *C* is shown a movable covering-tube of hard rubber or glass.

An exceedingly handy way to insulate a sound to any extent found desirable in a given case, after the proper curve has been given to it, and at the same time to thoroughly sterilize it, is to heat it to a considerable temperature in the flame of an alcohol-lamp or Bunsen burner, and melt upon it a sufficient coating of pure gum-shellac or sealing wax. This forms a smooth, highly insulating covering that adheres tightly to the sound, and shades off in thickness at the bare end so gradually as to readily admit a passage wherever desired. The fusibility of the shellac without burning is its greatest advantage over the best quality of sealing wax, but the latter may, however, be substituted for it if the shellac is not readily obtained. In covering the hot sound at first the coating retained by it is too thin for safe reliance, and it should be made heavier after cooling by attaching additional quantities of melted gum-shellac to it, the whole being then reduced to a uniform thickness by gentle fusing.

Fig. 31.—Author's Sound-Shaped Platinum Intra-uterine Electrode, with Fusible Covering of Shellac.

This procedure is only adapted to a rigid-shanked sound, though the curved portion may be flexible, for after the parts are once covered there should be no danger of the covered portion bending, as the material breaks easily, giving rise to leaks when in use. This disadvantage is, however, more apparent than real, for nothing is more trying in this work than an attempt to employ one of the flexible-shanked electrodes made by some manufacturers, who erroneously insist upon making the curved portion rigid and the shank flexible.

Fig. 31 represents the electrode usually employed by the author. It bears a general resemblance to the Simpson sound, with a hard-rubber handle of the usual flat shape for indicating its position *in utero,* and the addition of a socket for the attachment of the conducting cord. The two and a half inches which may be left bare at the extremity are made of platinum, to adapt it for use as a positive pole. The covering should be made to reach the platinum always, and it is

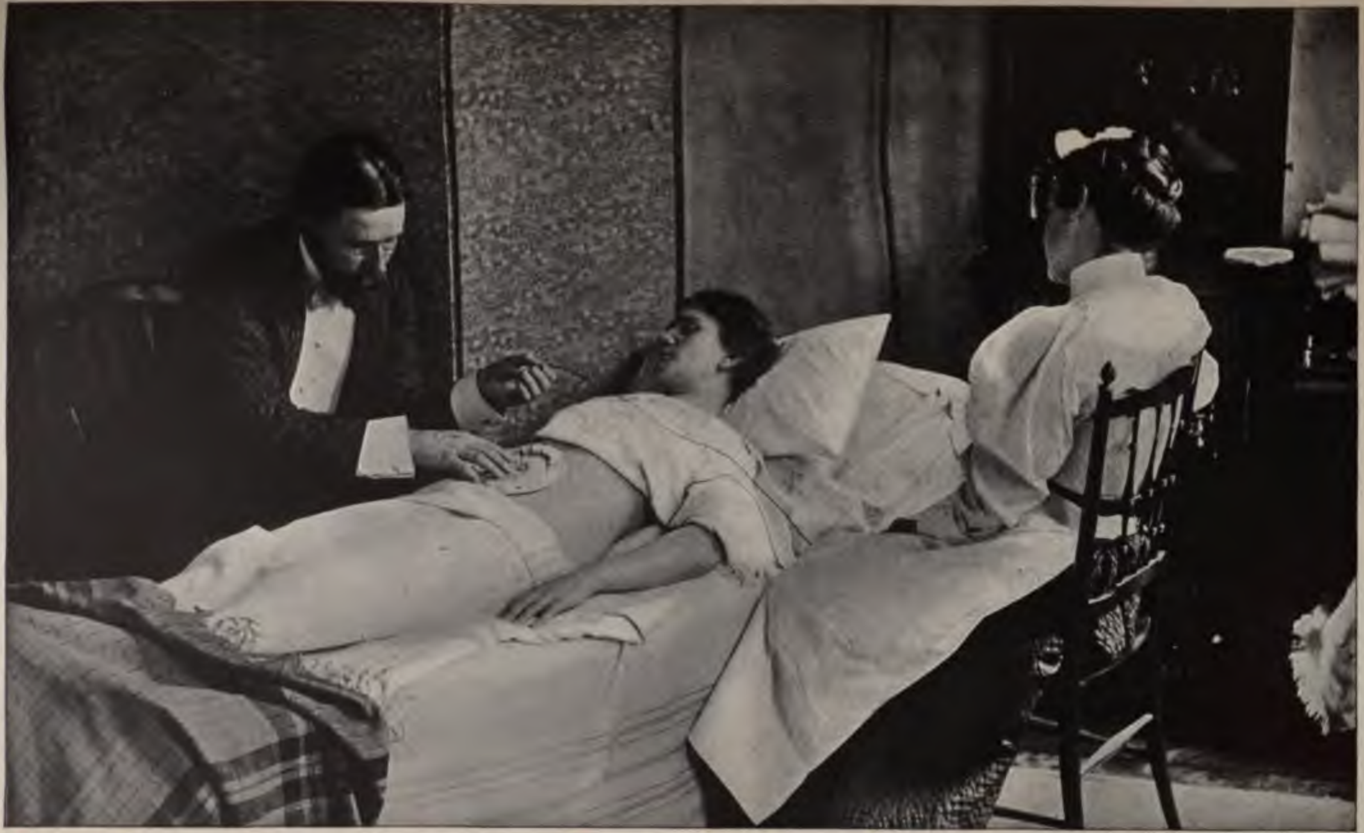


PLATE V.—Application to Abdomen, General Direct Stimulation. (From Photograph of Model.)

generally best to protect the os and cervix by carrying it to a point which will protect these parts when the instrument is in position.

Before each application, and after the desired curve has been imparted to the end, this electrode should be sterilized and any accidental breaks closed by a thorough heating of the bare part and fusing of the first two or three inches of the covering.

But, whenever it can be inserted, the best intra-uterine electrode for all noncataphoric applications is the author's spiral platinum electrode (Fig. 32), which conforms itself so accurately to the cavity as to be capable of insertion at times without being felt by the patient. Its painlessness and self-conformability even enable us to successfully employ intra-uterine applications at times when the uterus is fixed by subacute inflammations of the peritoneum or adnexa. Owing to these advantages, the author always selects it in preference to the stiff, curved electrode, unless the cavity is so tortuous or contracted as to demand the rigid instrument. If the uterus is sufficiently patulous and it is desirable to modify the local effect, it may be covered by twisting a light layer of absorbent cotton about the exposed portion as an applicator is covered, the cotton being then soaked in warm water and soaped, or moistened with an antiseptic soap solution. When properly applied it is impossible to lose the cotton within the uterus, and, in fact, it must be burnt off after use, as the spiral will be injured by much traction on it; the burning, however, though troublesome, is always necessary for cleansing purposes. The shank of this instrument is best insulated with shellac or sealing wax, as described, the material being carried down over the joint between the platinum and brass, permitting the whole instrument to be more thoroughly asepticized than would be possible with a movable or other cylindrical covering. The instrument was suggested originally on the lines of electrodes devised by Drs. Franklin Martin and A. H. Buckmaster, which consist of platinum wire wound about bougies, but these had the disadvantage of being capable of less thorough asepsis. An experience of fifteen years has convinced me of its great usefulness.

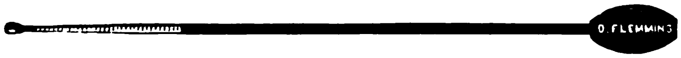


Fig. 32.—Author's Spiral Elastic Intra-uterine Electrode of Platinum.

In endometritis, accompanied by hemorrhages, and in incipient cancer of the cervix, I have recently employed zinc-mercury cataphoresis with one of the electrodes shown in Figs. 33 and 34 in preference to either platinum or carbon electrodes. They are also best insulated with shellac to preserve the joint between the shank and olive. Before use they should be cleansed by heating and then freely amalgamated by being dipped into a 10 per cent. solution of sulphuric acid and then into mercury. The result is a bright, smooth surface that is practically lubricated by the mercury, rendering insertion easy; and as the mercury coating is the metal acted on when it is used as anode, the electrode will not adhere to the surface even after a strong current has been used.

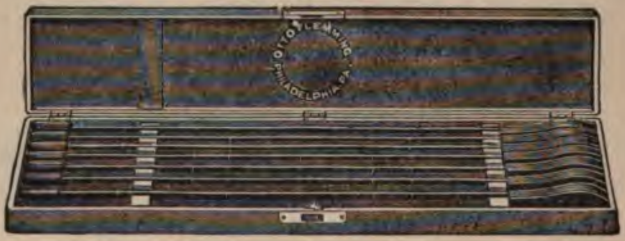


Fig. 33.—Set of Zinc Intra-uterine Electrodes for Mercuric Cataphoresis (Sizes 5 to 11, French Scale). The large size may also be used, when wrapped with cotton, as a vaginal electrode.

The increasing employment of mercuric cataphoresis in the author's intra-uterine applications has resulted in the practical disuse of late of any form of platinum electrode except the flexible elastic one, which, of course, possesses special indications. Whenever the positive pole of the constant current is needed the addition of mercuric cataphoresis is generally a help. The physician, therefore, rarely needs the rigid platinum electrode shown in Fig. 31, and may construct an admirable copper-mercury electrode to take its place by having an attachment socket drilled in any suitable copper sound, covering the shank as described for the platinum instrument, and freely amalgamating the tip with mercury before each application.

It is, as a rule, far easier to insert all intra-uterine electrodes by touch without a speculum, as advised by Apostoli, the position of the

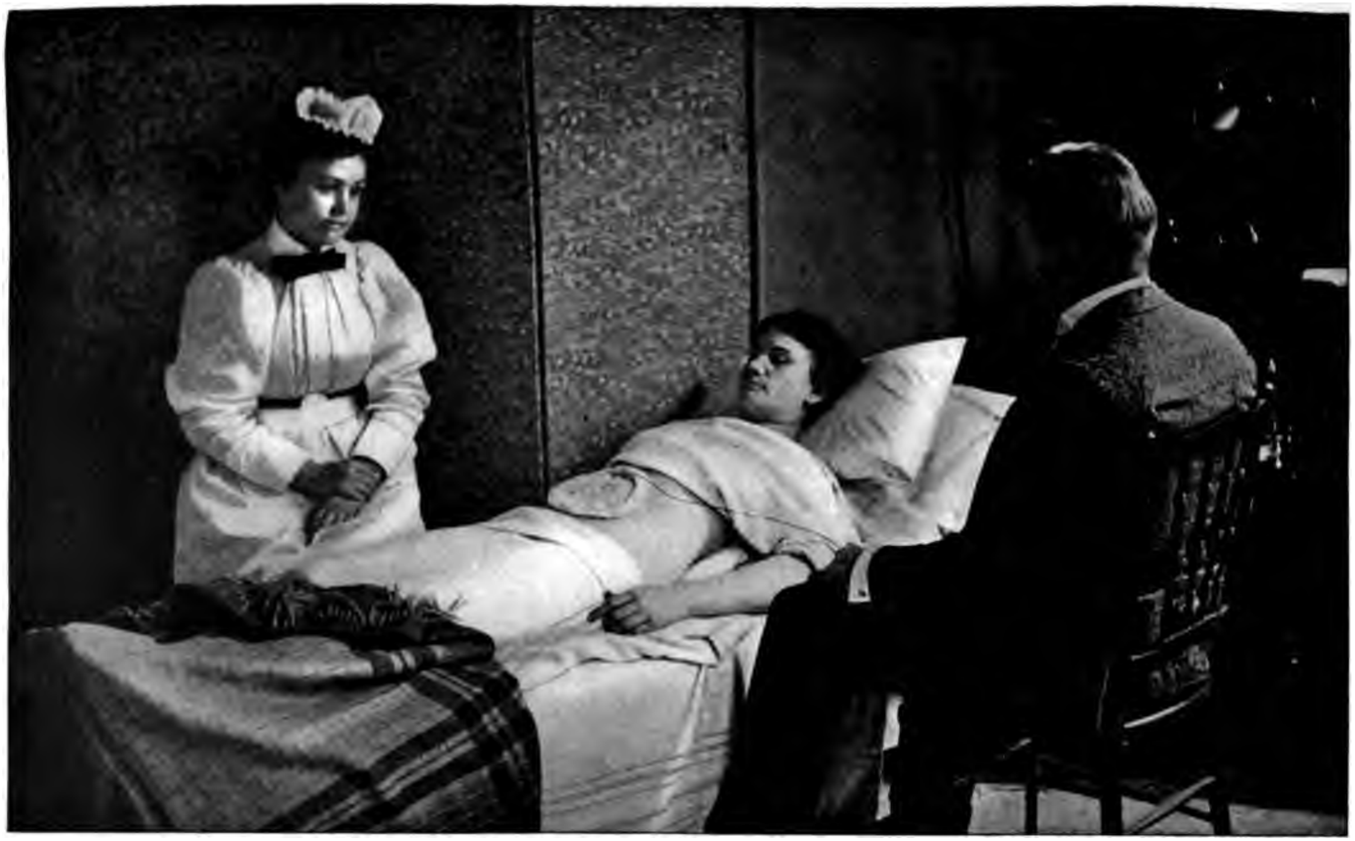


PLATE VI.—Stabile Induced Current Application to Abdomen, General Direct Current Stimulation. (From Photograph of Model.)

uterus previously ascertained by the bimanual touch being thus more readily followed than if sight is depended on (see Fig. 9).

The indifferent electrode may be either the large or small pad described on page 349, or, if the current is to be strong, an abdominal clay pad.

Position.—The dorsal position on a gynecic chair or table is the preferable one for this application, though the patient may lie across a firm bed with the feet on chairs or on the operator's knees, or may lie lengthwise in bed if the insertion is easy and the local conditions are familiar to the operator.

Preliminary Details.—Apostoli and most authors advise antiseptic flushing of the vagina immediately before each application, but the author has long since given up this tedious and often unpleasant procedure, relying altogether on a fire-cleansed instrument and scrupulous cleanliness of the finger in addition to the daily douche enjoined on some patients, and in many thousands of such applications has never encountered sepsis. The natural secretions of the vagina are in some cases an assistance to a painless insertion, acting as a vaginal lubricant.

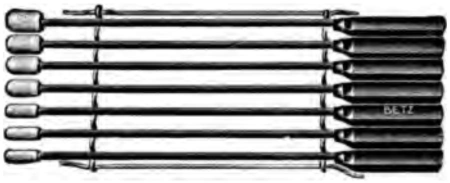


Fig. 34.—An Excellent Set of Zinc-Mercury Intra-uterine Electrodes.

Before inserting the instrument the proper working of the battery, soundness of conducting cords, and proper position of the switches should be ascertained, and, if no assistant is at hand, the indifferent pad should be first placed in position.

The Current Strength and Duration.—As the conditions in which intra-uterine galvano-chemic cauterizations are advisable vary from a slight, but persistent, endometritis of an otherwise normal uterus to the most extreme case of uterine hypertrophy, hemorrhage, or abnormal growths, so the efficient dosage varies through an even greater gamut of change, additionally influenced, as it is, by the individual idiosyncrasy as to pain. Where the hypertrophy is great, and especially where the uterus participates in the growth and abnormities of an intramural tumor, the strength may be as much as 150 or 200 milliampères, as it is very clearly established that the total effect depends more on the number of milliampères in circuit than upon the duration of the application. It is true, of course, that the actual amount of electrolysis produced by, say, 200 milliampères in five minutes can be secured by 50 milliampères in twenty minutes; but the effect in the latter case would differ nevertheless, for it would be entirely lacking in a powerful action within the interpolar region, which is depended on to influence the contractile tissue not directly affected by the cauterization. It should be remembered, therefore, that mere electrolysis does not describe the action obtained, and that the effect on nutrition of a single strong application is greater than that of several weak ones. Currents exceeding 50 milliampères in strength are, however, to be reached only after the tentative use of weaker currents.

On the other hand, slight cases of subacute or chronic endometritis, unaccompanied by hyperplasia, may be effectively treated and quickly cured by applications of 20 or 30 milliampères for five minutes, and, such being the case, it is manifestly improper to subject the patient to a more heroic treatment. In cases of hysteric or neuralgic pain, in which it is thought wise to use intra-uterine constant current applications, an even greater circumspection should be used, for cauterizations should be gauged primarily by the amount of organic disease present.

It is a safe rule, therefore, to gauge the dose by the amount of organic change within the uterus or in tumors closely attached to it, subject to modification at any moment on the appearance of pain.

As to the duration of an application not interrupted by the appearance of pain, I have every reason to commend Apostoli's rule of five minutes as an average application, though I frequently maintain it but four minutes. Given a large hypertrophy or tumor and easy tolerance of the current, it is better to extend the current increase rather than its duration, as there is less risk of producing breaks in the cuticle of the abdomen and the resultant burns.

Minor Details of the Application.—1. The patient's clothing should be sufficiently removed at the waist to render it easy to apply the indifferent pad without wetting or soiling it.

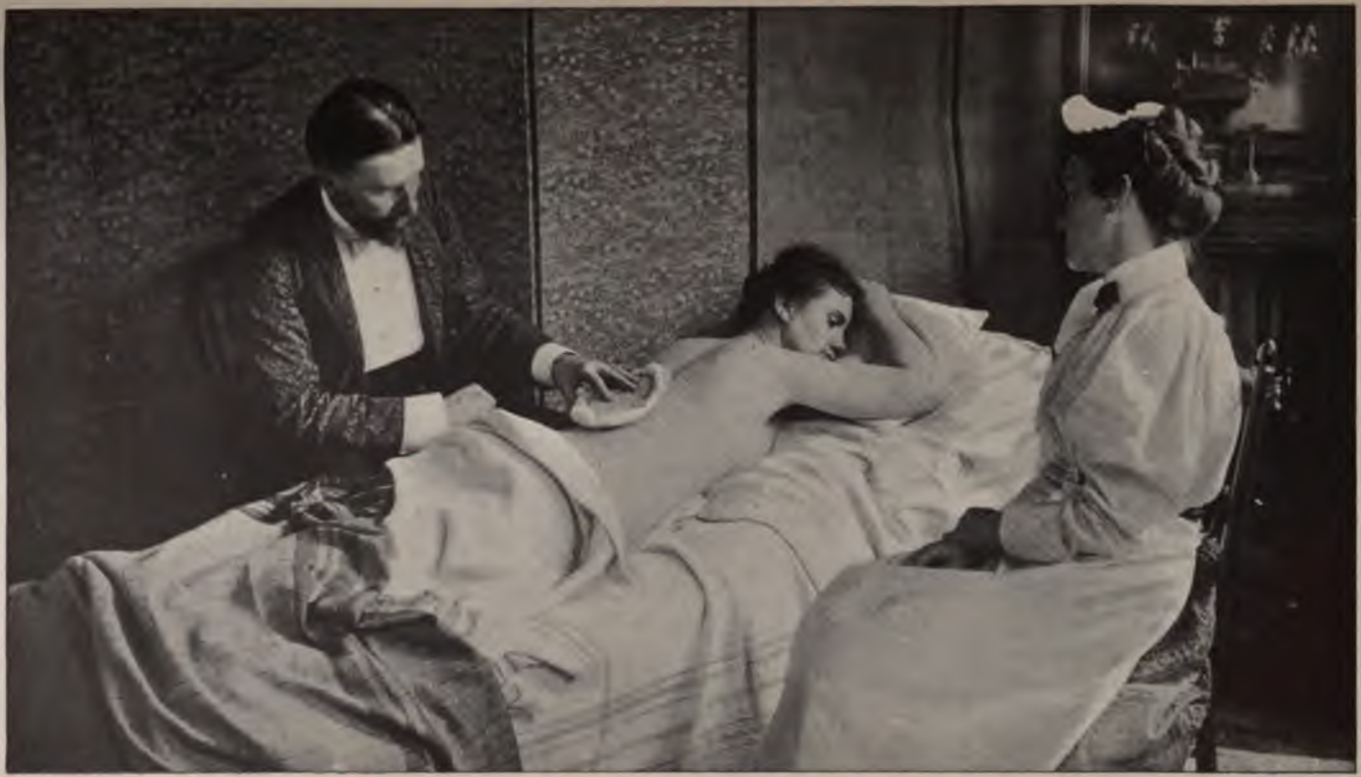


PLATE VII.—Dorso-abdominal Application, General Direct Current Stimulation. (From Photograph of Model.)

2. If there are any abrasions or pimples on the abdominal surface, they should be covered with pieces of paper smeared with vaselin, or in some similar manner, before the indifferent pad is applied.

3. The insulation of the active electrode should always be examined for imperfections before insertion.

4. Glance at the controller to make sure that no current is on before inserting the active electrode.

5. Pain may be relieved by only a slight reduction of the current.

6. Both patient and instruments should remain motionless during the application, to prevent accidental pain from current variation.

7. The patient should be warned that she may have colicky pains within six hours after treatment, followed by soreness the following day, and that the leucorrhea may be temporarily increased.

After the Application.—It is usually best to have the patient rest a while before going home, but if a means of conveyance is handy this will not be necessary. In every case, however, where at least 100 milliampères have been used, she should lie down after reaching home and remain inactive during the remainder of the day. It is well to tell her plainly that a neglect of this precaution may cause serious congestion, entailing much discomfort.

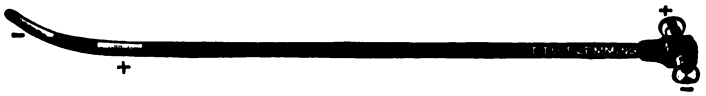


Fig. 35.—Apostoli Bipolar Intra-uterine Electrode with Fusible, Aseptic Covering.

Contra-indications. — The intra-uterine electrode should, of course, not be inserted either as a sound or electrode at any time during pregnancy, and the physician is wise to make inquiry as to the regularity of the periods in every case before inserting it. Certain patients will too gladly refrain from enlightening him if they can do so.

It should not be inserted during acute inflammations of the uterus or the adnexa, though an elastic, cotton-covered instrument may be safely employed with mild currents within the cavity in subacute salpingitis after a course of vaginal applications. The question of employing intra-uterine applications as a diagnostic and a therapeutic agent in these conditions will be found discussed elsewhere.

Finally, intra-uterine applications should never be made for neuralgia or general conditions of any character, being reserved strictly for cases involving organic changes in the uterus itself.

Intra-uterine Induction Applications.—It is quite customary in the author's practice to turn on either a primary or secondary induction current, monopolar, after a constant current application to the uterine cavity, for its contracting or sedative effect, though it is rare that an instrument is inserted into the uterus for the induction current alone except in early cases of subinvolution. When inserted for this current alone it is preferably bipolar, the Apostoli instrument (Fig. 35) having been so modified by Flemming, at my request, as to permit it to be asepticized in the flame. This is done by substituting fused hard rubber and shellac for the tubing usually on these instruments. The indications and choice of coils are discussed elsewhere (page 368).

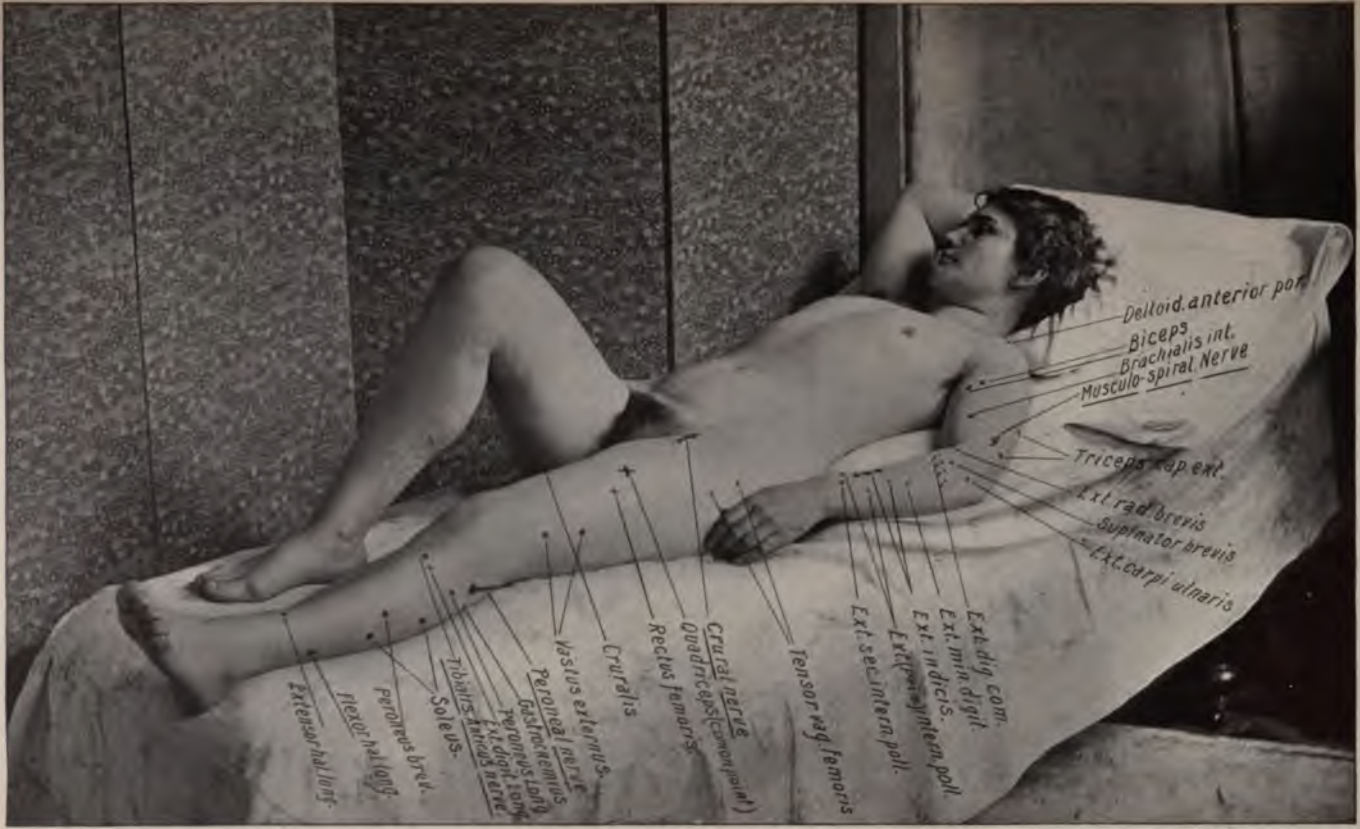


PLATE VIII.—Motor Points of Anterior Portion of Body. (From Photograph of Model.)

CHAPTER VI.

ADDITIONAL SYSTEMATIC METHODS IN GYNECIC PRACTICE.

WHILE the author believes that in the rational and thorough application of electricity the physician has the most potent means of combating a large proportion of the chronic organic and functional diseases of women for the reasons given elsewhere, he by no means underestimates the remedial value of a number of other methods of assisting nature in re-establishing a normal nutrition and normal performance of function. Some of these methods may be here described, particularly those coming under the general description of means that may be used alone or in conjunction with electricity in curing these affections without resorting to surgery.

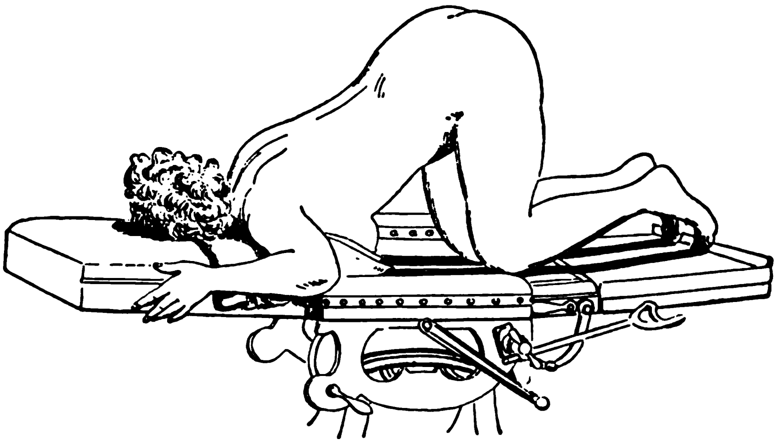


Fig. 36.—Knee-Chest Position. (Drawn from Photograph of Model.)

Posture.—We are indebted to Dr. H. F. Campbell, of Georgia, for a systematic method of replacement of prolapsed and retroverted uteri, in which the normal gravitation of the vagina is reversed by placing the patient in the knee-chest position (Fig. 36) and admitting air into the vaginal cavity. In the conditions of relaxation of the vaginal and abdominal walls present in these affections the admission of the air permits the parts to fall forward by their own weight. This is the only proper method of reposition of these parts by the physician prior to inserting the sound, but is especially advocated by Dr. Campbell as a "pneumatic self-replacement" method by which the patient herself inserts a small tube while in the posture when retiring at night and on rising in the morning. Any short tube with rounded edges will do for this purpose, preferably a small glass tube, but the detached vaginal nozzle of a syringe answers every purpose. It is important to remember that the clothing about the waist should be well loosened before resorting to this valuable procedure, and that the thighs should be perpendicular, as shown in the drawing, with the sternum directly in contact with the couch.[1]

Hydrothermal Applications to the Pelvis. — *The Hot Vaginal Douche.*—Vaginal injections are of service in a variety of ways, either for cleansing purposes or for vaginitis, and as a method for modifying the circulatory and nutritive conditions of the pelvic organs. It is their use for the latter purpose that requires mention in this place.

Emmett was the first to popularize the use of the hot douche of sufficient bulk to modify pelvic conditions and administered in the recumbent position, and it may be stated that it is only in this position and when followed by repose that it is valuable as an alterative. It is readily administered by the nurse while the patient lies in bed by the use of a bedpan and a pillow laid just above it, a board being slipped under the sheet if the mattress be soft and yielding. It may also be administered by the patient herself as follows: Procure a square yard of rubber sheeting and lay it on one side of the bed with the projecting side draped to convey the water into a vessel placed beneath it on the floor. Then fill a two-quart fountain-syringe with plain or medicated hot water of a temperature barely permitting the hand to be held in it, and hang it on the headboard of the bed at a height of about two feet from the mattress. Then lie across the bed with the hips on the rubber sheet and the vulva close to the edge of the bed, each foot being supported on a chair drawn alongside, when the nozzle may be inserted and the catch released.

---

[1] Dr. Skene limits this procedure as a self-treatment to this position only, wisely condemning any elaborate efforts at self-medication.

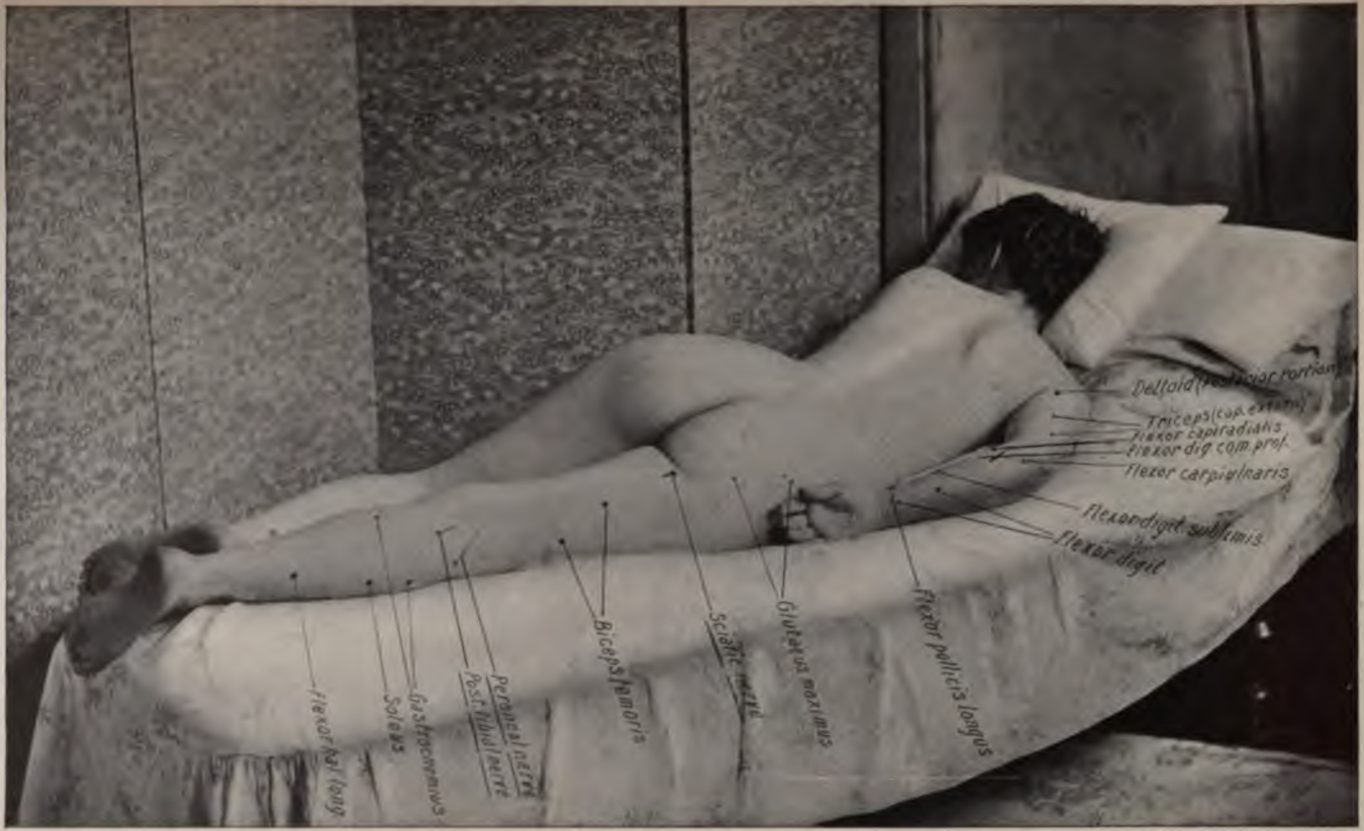


PLATE IX.—Motor Points of Posterior Portion of Body. (From Photograph of Model.)

The nozzle should be constructed with side-openings only, and should be of large size at the tip to prevent injection of the water into the uterus,—an accident that has frequently resulted in painful, and even dangerous, uterine contractions. Improved devices are now sold for vaginal douching, particularly instruments which occlude the vulvar opening and compel a dilatation of the rugæ of the vagina and a more thorough application of the fluid.

The remedy is unquestionably a valuable one in acute and subacute pelvic inflammation, and particularly in pelvic peritonitis, but the author sees many cases of more chronic inflammation in which it has failed to be of use. A word of caution should be said concerning the relaxing and what might be called tactile benumbing effects of this procedure when practiced for too long a time. Certain cases of abnormal relaxation and insensitiveness have been observed by me in young women who had gone through a course of treatment of this nature, but this may have been due to the fact that they had been led to continue the practice indefinitely for the temporary relief afforded, or by reason of a belief in its necessity as a means of keeping "clean." Now it is quite evident that nature never designed that these sensitive parts should require cleansing in this way, and that even the repeated contact of simple water may have a hardening effect on virgin surfaces, at least, that are normally bathed in mucus. The normal vagina is quite capable of attending to its own cleansing in a physiologic way. If this secretion is abnormal the douche is, of course, imperative, but when the abnormal secretion is of uterine or tubal origin, something more definite in the treatment of the seat of the discharge is needed and no amount of vaginal washing will be effective.

Vaginal Swabbing.—For refractory cases of colpitis the best application is a douche of sublimate solution, 1 to 5000, administered by the physician through a speculum; or the vagina may be swabbed out with pledgets of absorbent cotton dipped in the same solution or in equal parts of tincture of iodine and glycerin.

The iodine and glycerin swabbing is also a favorite method with some in the treatment of chronic pelvic inflammation, whether affecting the uterus and appendages alone or the cellular tissue, but is usually inferior to vaginal mercuric cataphoresis or positive vaginal applications of the constant current with a cotton-covered electrode.

Tampons. — The tampon, constructed of a cylindrical wad of absorbent wool, or, in its absence, of absorbent cotton, has of late become a favorite routine treatment for chronic pelvic inflammation and for conditions of the uterus formerly treated by pessaries. For this purpose the tampon is medicated with various substances, chiefly boroglyceride, glyco-thymoline, or some other preparation of glycerin for its drainage effect. In constructing the tampon for this purpose a piece larger than the palm of the hand is spread out in the form of a cup and the boroglyceride or glyco-thymoline poured in; the outer portions are now brought together and tied with a string long enough for both ends to project beyond the vulva. It is now inserted quickly through the speculum already in position by means of dressing forceps, enough cotton being left dry to prevent the liquid from exuding. This is left in from eight to twelve hours, at the end of which time it is withdrawn by the patient by traction on the strings, and the vagina is thoroughly douched.

In the use of the tampon for checking hemorrhage the Sims position and the Sims speculum are decidedly preferable, the vagina being packed full of iodoform gauze by tucking in a little at a time and packing the vault first. In the absence of the gauze, pledgets of absorbent cotton dipped in a saturated solution of alum and pressed dry may be used instead. The tampon should be removed by the physician himself at the end of twenty-four or thirty-six hours, and the vagina should be cleansed and repacked if necessary. This procedure is invaluable in dangerous hemorrhages, but is rarely necessary when we have at hand the primary, or the coarse-wire, induction current, by means of which the source of the bleeding may be directly controlled by causing immediate contraction of the uterus.

Pessaries.—Of pessaries and other artificial supports for the uterus the author has but little to say that is not condemnatory, since they usually produce a harmful distension of the vagina, with ultimate disappearance of the muscular coats. He has been able to obtain better results by electricity in all cases except those of pronounced paralysis or muscular degeneration of the vaginal walls (generally contributed to or caused by a long course of pessary wearing) with cystocele or rectocele, and in this exceptional class alone has obtained good results from the Smith-Hodge pessary where the perineum was at least partially intact.

Massage.—Massage, or the art of applying intermittent mechanical force to the tissues of the body, is a most important adjuvant to electricity in the treatment of the neuroses of women and the neural consequences of pelvic and abdominal disease. In the disorders under consideration it becomes of value mainly as a peripheral application and as a means of restoring general nutrition. As such, it is a necessity in the "rest," or Weir Mitchell, treatment, and may be useful at times, though less frequently, in the treatment of ambulant cases. For descriptions of the methods of applying massage and of its physiologic action in the cure of disease the reader is referred to the works of Schreiber, Douglas Graham, Dowse, and others.

The author regards massage with the hand as the only efficient method of using the agency in the class of cases under consideration, rejecting all machinery, muscle-beaters, etc., as either but poor substitutes for the hand of the *masseur* or as presenting an entirely different therapeutic measure.

Most books on massage treat more fully of Swedish movements than of massage proper. While the former have a very great value in many chronic conditions, the latter is particularly indicated in the class of affections under consideration, the Swedish movements being added in the shape of passive movements of the joints only.

CHAPTER VII.

THE BORDER-LINE BETWEEN NEUROLOGY AND GYNECOLOGY.

THE restriction of the term "gynecology" to the pelvic diseases of woman is largely artificial and often harmful in leading to serious errors of practice. A treatise on the diseases of woman necessarily includes an account of all of the affections which are either peculiar to her sex or which are so frequently manifested among women as compared with men as to be more or less sequential to their general bodily, mental, and emotional natures. That there is no self-evident line between the strictly pelvic and the extrapelvic affections peculiar to women was manifest to the author many years ago while enjoying, at different times, the valuable privilege of professional association with two of the most prominent practitioners of America in apparently different lines of investigation,—Drs. S. Weir Mitchell and the late William Goodell,—and it was a singular fact to note that the eminent neurologist was most solicitous that his cases should have the benefit of skilled surgical advice whenever any indications even pointed to this necessity, while the eminent surgeon, at the height of his masterly work in the major surgery of gynecology, had the mental breadth to keep his private hospital filled with patients undergoing what was strictly neurologic treatment, while he might have easily followed the prevailing fashion and removed the ovaries of every one of them.

But the average of professional work or breadth of character cannot be predicated from such men as these, and it is to be feared that like conditions of discernment and cool judgment are often wanting in both specialties, though it may be said of the neurologist, at least, that a too narrow viewpoint cannot lead so easily to disaster to the patient as in the case of his brother specialist.

And, indeed, no more difficult class of cases, from the point of view of their diagnostic classification, can be found in the practice of medicine, and unless the physician has both a gynecic and neurologic facet to his crystallized experience he may make mistakes. The author particularly recalls a case under his care before the development of his gynecic training where evidences of hysteria were associated with a vulvar discomfort, which could have been none other than a minute caruncle. An imperfect examination was made, but the slight evidence of local disease did not seem to bear an etiologic relation of importance to the very manifest hysteric symptoms existing, and the case was treated entirely from the neurologist's standpoint with but partially satisfactory results. A retrospective review of its management makes it evident that the local affection should have been carefully sought for and remedied simultaneously with the neurologic treatment, care being observed to so adapt and direct the latter that the patient's attention was attracted away from an undue contemplation of the local symptoms.

In the management of these cases of manifest hysteroid conditions associated with local disorder or lesion, whether pelvic or extrapelvic, it is clearly our duty to correct the local faults while pursuing measures to eradicate the main affection; but I believe the profession will agree with me that too much stress has been laid upon the so-called "reflex" causes of nervous disease in recent years, though no one can deny the real importance of reflex nerve-strain from a degenerating or badly functionating organ. Ovarian congestion and tenderness have been specially frequent in these border-line cases, and these organs have been removed time and again for conditions of exaggerated nervous disorder without securing the expected relief, for the simple reason that the ovary was not the seat of the real disease, but merely the spot at which appeared the peripheral expression of a centric disease of the nervous system. Such a course of procedure was, moreover, incorrect in the nature of the local remedy applied, for it should not be forgotten that centric disease may be favorably affected by peripheral applications to the end-organs through which it expresses itself, the remedy in these cases not having been a curative removal of the congestion or tenderness, but a violent amputation of a but slightly diseased organ, thus adding a distinct blow to an already unpoised nervous system. In place of such heroic procedures we should substitute the locally alterative action of vaginal electricity, which is capable not only of removing the local congestion or hyperplasia, but, also, of producing a very valuable centripetal effect upon the disordered cerebral centers.

An interesting demonstration of the latter truth is recalled in the case of a young lady referred to the author some years ago by the late

Dr. Pepper, her home physician reporting that the pain and tenderness in the region of the left ovary had become so great that she was rapidly drifting into the dangers of morphinomania. In addition to the marked hysteric condition present, there was distinct bogginess in the region of the ovary complained of. This speedily diminished under positive vaginal treatment with both currents applied by a small cotton-covered electrode and abdominal pad, associated with removal from home surroundings, general electricity, and massage, resulting in complete cure. The local conditions of this case were exactly similar to those of the following cases, both of which were, however, more virulent in their hysteric condition, and ultimately illustrated the fallacy of the theory of a local pelvic origin of this protean disease of the brain.

A young girl, of plain Pennsylvania-German parentage and the picture of wholesome physical girlhood, was the patient of an able practitioner who had long been the family physician. During the serious and finally fatal illness of a younger sister a latent neuropathic diathesis became prominent in this patient, who went through an elaborate mimicry of the traumatic spinal meningitis of which her sister suffered in the same room, and seemed desirous of diverting to herself all the attention of a too solicitous mother. After various changes in the manifestation of the neuropathy, and many therapeutic efforts on the part of her physician, she was sent to the Infirmary for Nervous Diseases and placed under seclusion, rest, and massage without adequate electric treatment. About this time the patient's attention became fixed on a pain in the pelvis, aggravated at the periods, and her physician finally decided that the removal of the ovaries would be wise, which was successfully done. The pain, however, became worse than ever after the operation, and nearly a year afterward her physician sent her to the author in despair. The uterus was now fixed and extremely tender at the stumps of the ovaries, with probably one or more irritating ligatures in these positions, and the local electric treatment that she was willing to receive was of little avail. Obstinate bowel obstruction gradually developed later, for which a second operation was performed, this operation revealing a postoperative adhesion between the appendix and the stump of the right ovary. The patient failed to rally from this operation, expiring some hours later.

A similar case in some respects was admitted to the sanatorium from Northern Ohio in 1895, the young lady's physician sending her for treatment for an adherent right ovary, which was also enlarged and tender: a diagnosis which had been made by himself and a distinguished surgeon of Cleveland. Fortunately for the possibilities of a fuller diagnosis, the patient's aunt accompanied her to Philadelphia. An examination on admission led me to conclude that the pain complained of in the pelvis was mainly uterine in seat, no considerable periuterine or ovarian disease being manifest. I was, moreover, led to suspect an overwhelming neuropathic taint from a peculiar glitter of the eye which will frequently be found in hysteric cases, and from the very apparent evidences that her family were unsuspectingly fostering her aches and pains: a view of the case that was not shared, at this time, by her physician.

She was placed on combined neurologic and gynecic treatment, consisting of general electric treatment, massage, and regulated exercise, and daily vaginal applications of the constant, followed by the induced current, interspersed with weekly intra-uterine applications of the same currents, and was sent home in a greatly improved condition with full directions for a continuance of the methods at the hands of her home physician. This gentleman has kindly informed me since that the methods were not continued, but that laparotomy with removal of the ovaries was performed instead some months afterward, these organs being found normal and free from adhesions. The patient unfortunately succumbed to the operation.

The fact that these two patients died as a consequence of the operative procedures undertaken for their relief is, of course, not in itself a condemnation of the methods or the theories behind them, for in both cases the deaths were caused by accidental circumstances connected with operations that are usually more or less safely performed, though the fact that such possibilities attend a method of treatment of a nonfatal disease should never be lost sight of. But that clearer after-sight that is often more accurate than foresight shows that the remedy was disproportionate to the disease, particularly when we consider what would have been the natural history of the disease if all therapeutic efforts had been withheld, as in the cases of pneumonia studied by the elder Flint many years ago. Undoubtedly both patients would have been still living, so far as the diseases under consideration are concerned. It is likely, also, that both would have been better by reason of changed internal and external conditions through flux of time, or by reason of the too indulgent relatives either mending their ways or being worried to death; at any rate, the patients would have remained alive.

But entirely apart from the accidentally fatal results noted in the two cases, each case indicated in another way that the local conditions were inadequate in themselves to cause the general condition complained of. In the one case the first operation, which was in every way an immediate success, left the patient in an unchanged neurotic condition, to which was added the sufferings from postoperative sequels. In the other case the early fatal result precluded any estimate of the effect of the operation in relieving pain, but, by revealing the fact that there was no organic disease or morbid adhesion present, the operation clearly indicated that a failure in this respect would have attended an immediately successful result.

A thorough study of cases of this nature conveys several valuable lessons to the thoughtful physician, chief of which is that they, with many other immediately successful cases, demonstrate ultimately the unwisdom of removal of normal ovaries for any form of hysteria. Of castration for curable diseases of these organs reference will be made elsewhere in these pages (page 110).

A second lesson admonishes us to include the patient's relatives in our scheme of treatment when it is impracticable to remove the patient from their influence for a sufficiently long period. In the case treated after the first operation the electric treatment was rendered ineffective by the fact that the patient remained at home during its continuance. In the last case the removal from home influences was a valuable assistance to the treatment employed, and the patient was vastly improved when circumstances rendered it necessary for her return to surroundings that had been nervously hurtful since her birth. Had it been possible for this patient to have obtained congenial occupation elsewhere, which was suggested at the time, there is no doubt but that a complete restoration to health would have occurred.

Differential Diagnosis between Hysteria and Neurasthenia.—The determination of the preponderance of hysteric or neurasthenic features in a case is most difficult in actual practice, and, while even a partial discussion of the question is beyond the scope of this work, it may be useful to mention a valuable point to which attention was first called by the late Georges Apostoli. This writer asserted that a large proportion of patients affected with hysteria feel little or no pain when static sparks are administered to them, while neurasthenic patients invariably shrink from this treatment, its painful features being exaggerated. The reason for this is doubtless the well-known prevalence of anesthesia and analgesia in hysteric persons. Certain it is that this differential index has been found by the author extremely valuable in doubtful cases, and when the spark treatment is used as a therapeutic measure in hysteric patients, their improvement coincides with a gradual increase in the pain effects of this procedure.

The Rest Cure in the Treatment of Hysteria and Hysteroid Affections. — There is no question of the very great value of the "rest cure" in two distinct classes of affections: the hysteroid conditions, and physical prostration, sometimes called nervous prostration. Dr. Weir Mitchell, its distinguished originator, conferred a lasting benefit upon humanity in making this method popular, and it should also be added that great credit in this connection is also due the late Dr. William Goodell, who proved that many so-called uterine affections were of really neurotic origin—"nerve-mimicries of uterine disease"—and distinctly curable by this method. That many cases have been subjected to this treatment that were not proper subjects for it, and that it has been imperfectly applied, does not detract at all from its value when skillfully directed in properly selected cases.

It is probable that the principal failures in the employment of this method have been due not only to improperly selected cases, but to a misapprehension of the method itself. He who imagines that the "rest" is the main feature of the method in any case other than mere physical prostration is far wide of the mark. This convenient and pleasing term is only the name for a most rigid method of treatment, which has as its chief elements the replacement of drug medication by valuable physical methods of affecting the body, associated with a rigid diet and a command of the will-power of the individual. In most cases the rest is a mere incident in the subjection of the patient to more important influences.

I have already said that its chief field lies in the hysteroid conditions, and in these the most rigid application of its rules is most valuable. Without attempting the difficult task of defining these conditions I wish to point out that cases with hypochrondriac symptoms are not necessarily hysteroid, but often neurasthenic, as described in the next chapter, and that these cases are poor subjects for the Weir Mitchell method, mainly because the seclusion is harmful. Cases of physical prostration from absolute, not relative, overwork are also good subjects for the method and respond readily to it.

The chief features of this method, as employed by the author, are: complete removal from accustomed scenes and associates and rest in bed under the care of a specially trained nurse, who screens the patient from all communication with her friends for a definite period, usually at least four weeks. During the first two or three weeks the patient remains at absolute rest in bed, though she may rise to attend the calls of nature in all but the most extreme cases. Massage is given daily in the morning. In the afternoon general electric stimulation is applied, preceded by the local electric treatment to the pelvis or to the stomach which may be indicated in the particular case, and which is often so important when there is evidence of a reflex origin of the nervous symptoms.

The diet during this time is carefully specified, beginning with milk alone, 1 quart *per diem,* during the first seven days, to which toasted bread is added at mealtimes in some cases. During the second week koumys is taken between meals and cocoa replaces the milk at breakfast and supper. In the third week full diet may be given, followed by from 3 to 5 drops of freshly prepared, chemically pure nitrohydrochloric acid in 3 ounces of water after meals, the koumys being continued between meals.

The getting up, which begins at the end of the third or fourth week, should be very gradual,—at first, a half-hour, once a day, increasing a half-hour each day.

After the patient completes her getting up she continues the general electric treatment for a while longer, depending on the case, requiring an hour's rest after each daily application, and receives static insulation and breeze from a powerful machine in the other half of the day in place of massage.

CHAPTER VIII.

NEURASTHENIA AND NERVOUS PROSTRATION.

NEURASTHENIA, or the American disease, first described by the late George M. Beard, to whom American physicians owe the rescue of electro-therapeutics from the blighting effects of quackery, has been the subject of much study and many treatises in several languages, as physicians the world over recognized that its occurrence was by no means limited by political boundaries, nor even by the existence of the environments of a new country. That it is peculiarly a disease of modern civilization, even though described to some extent by Burton in his "Anatomy of Melancholy," published in 1621, is but another way of saying that it is one of the penalties of that evolutionary development under which society is continuously progressing.

Of the exact nature of neurasthenia several views are current, the most reasonable being that it is a symptomatic manifestation of an imperfect performance of all, or nearly all, of the organic functions of the animal life causing perversion of the nutrition and functionation of the nervous system. Though it may be caused by a sudden mental shock, such a causation is unusual, and the cases in which it occurs are more nearly related to hysteria. The assumption that excessive occupation due to the claims of business or society is a frequent cause is but relatively true, for in a normal condition it is not work, but worry, that tells hardly upon the individual. In the abnormal conditions of alimentation and excretion, which are probably the primary cause of neurasthenia, a persistence in any occupation requiring a high grade of mental work or irregular hours becomes a persistence in relative overwork, though the same exertions may be harmless under more normal conditions.

The view that assigns the many functional derangements of the nervous system comprised in neurasthenia to an autointoxication due to an imperfect performance of the abdominal functions is gaining ground, and is evidenced by the recognition of lithemia, in many cases, in association with the nervous symptoms.

An enumeration of the symptoms of neurasthenia would occupy more space than is available in a work of this nature. Considered as a whole, the subjective symptoms usually display, in a most varied way, a more or less pronounced inability to perform with personal satisfaction the various tasks imposed upon the individual by the necessities of a social existence. Of objective symptoms the most pronounced are due to disordered action of the sympathetic system of nerves, disordered circulation, and general metabolic sluggishness.

In the treatment the main purpose should be to arouse the defective activities of the abdominal sympathetic nervous system and of the organs under its control. The effectiveness of peripheral applications, such as the cold bath of momentary duration or applications of static electricity, in restoring circulatory and nutritive control, is no argument against the abdominal origin of the malady, as these agencies exert powerful afferent effects on the sympathetic ganglia as well as upon the cerebro-spinal centers of innervation. Of this nature are also vibration therapy, massage, and electromotor stimulation of the limbs and body-surface, with the added advantage of a stimulation of the local circulation, nutrition, and tissue-metabolism; but, unless the abdominal sympathetic system is directly reached, the worst of these cases will fail of complete remedial alleviation, and dissatisfaction will result to both patient and physician.

Rest and regulation of the diet added to these peripheral stimulations will do much for some of these cases, but will be lamentably ineffective in others. The importance of rest alone has been enormously overrated of late, so much so, indeed, that hundreds of patients who have done nothing but rest all their lives are put through a costly treatment by their physicians under an inordinate belief in this shibboleth, only to find their neurasthenic symptoms made worse by the burdensome effect of temporary additions of fat, or their hypochondriac symptoms intensified by a prisonlike confinement. In Philadelphia alone a number of such cases have leaped from their bedroom windows. The fact that partial rest each day, away from home and under the surroundings of a well-regulated sanatorium, is a most valuable portion of the treatment will not make rest at the patient's home or in a boarding-house of equal effect. Shorn of its institutional setting, change of surroundings, and the expectancy that occurs when a number of such persons are treated together, this feature of the treatment is as often harmful as useful. Rest and surface treatment in lounge-ridden cases are much like certain farming observable in neglectful sections of the country, where the surface-scratching of superficial farming fails to supplement the fallow rest in producing good crops. In neurasthenia the causal conditions should be stirred from the foundation by appropriate medication and applications to the abdominal sympathetic. Electricity applied directly to the abdominal organs is a most valuable means of accomplishing this, and it should be supplemented by appropriate doses of exercise as well as rest,—the rest to follow each dose of electricity or mechanical exercise.

Electricity has been used for years in this country in the treatment of neurasthenia, but it is to be regretted that its use has partaken so largely of the antiquated Duchenne methods as to be closely analogous to the soil-scratching style of farming referred to and equally imperfect in results. Even when retained in the hands of the physician or an intelligent assistant these methods are merely a surface excitation, and fall far short of the possibilities that have been demonstrated by modern electrotherapy. Unfortunately, the battery is often relegated to the nurse under imperfect instructions, which lessens still further any good results it might give.

Aside from the assumption that an agent of this nature can be employed properly by unskilled persons, the fault of the Duchenne methods of motor stimulation in neurasthenia are: too great a reliance on the limited value of induction currents; the use of electrodes of inadequate size in the applications to the trunk, resulting in an insufficient current-density at any point beneath the surface-muscles; and failure to apply currents of effective density to the abdominal ganglia and viscera.

The excellent results derived from constant currents of 50 to 150 milliampères in the utero- or vagino- abdominal applications of the Apostoli method first directed my attention to the value of large electrodes and considerable currents in these conditions. As a result of these gynecic applications, an improved general health is almost invariable, which, though in part due to the control exerted over the growth, must be often largely due to the necessary inclusion of the abdominal structures in the field of the current. Almost as good results in the stimulation of the sympathetic may be gained by placing the indifferent electrode beneath the back, in the shape of a very large wired-cotton pad, and the active one, which should be six or seven inches in diameter, on the abdominal surface. A greater effect is obtained if the active electrode is given a circular motion, being lubricated by soaping, as all portions of the abdominal contents are thus successively brought under powerful electric stimulation.

The same pads are also useful in the administration of deeply penetrating induction currents; which may follow the constant current stimulation and should be primary; but time and effort may be economized by combining the primary induction with the constant current after the constant current alone has been employed, as this combination is peculiarly powerful as a motor stimulant of relaxed muscular structures of all kinds, giving all the attainable efficiency of induction currents, while the more valuable constant current action is continued.

The applications to the peripheral motor-sensory apparatus are also best made by the constant current instead of the induction, the patient continuing to lie on the large pad, while the smaller one, which is to be kept negative and well soaped for lubrication, is carried over the motor points of each group of muscles of the limbs in a labile manner, all shock or unpleasant sensations being avoided by the free use of the controller and meter, the former permitting the current to be turned on after the pad is in position and off before it is removed from the limb. Only those muscles that are physiologically associated in action should be included in the same upward and downward strokes of the pad. For full particulars of the mode of applying general constant current stimulation the reader is referred to Chapter V. As complete motor stimulation of all the voluntary muscles is thus gained as is produced by the induction current, with a greater stimulation of the peripheral nerves and tissue-metabolism. The sense of exhilaration is more marked than with the induction current, and greater warmth of the extremities is produced.

With scientifically applied currents as the principal feature of the treatment, other measures are conjoined as required, including massage if the bodily condition is much below normal, rest for an hour after each treatment, nitrohydrochloric acid if the liver is sluggish,[1] and possibly a gentle laxative for a time. In many cases thus treated the diet requires but little attention, for, above all things, we should not pamper the stomach, but rather whip it into obedience. The final result is apt to be a far more lasting acquisition of healthy blood and flesh than if the main features of the treatment were rest and overfeeding alone.

---

[1] I believe that the freshly prepared C. P. NHCl has a far-reaching effect in lithemic conditions, independently of a sluggish liver, unless hyperchlorhydria is found to be present.

In some cases, however, where the nutrition is decidedly at fault, absolute rest may be used with great advantage for a time in connection with the other remedies, but, if the electric treatment be of the kind described, the duration of absolute rest need not be greater than two weeks, to be followed by two or four weeks of the electric treatment under the rest-and-exercise plan before the patient returns to the active affairs of life.

The value of this modification of the "rest cure" has been attested by a number of years' successful employment without a single failure, though previous experience with the rest-and-overfeeding method resulted in a number of partial failures to permanently cure the patient.

Another most valuable systematic treatment of neurasthenia is that by static insulation, the static breeze, and light sparks drawn from the most affected portions of the body. This method is specially recommended by Snow, Morton, Vigoroux, and others, and probably acts by a general vasomotor and metabolic stimulation. Recovery is often indicated by an increased perspiration under treatment, particularly in cases that presented a suppression of this excretion.

On re-entering active life the former patient should remember that her indisposition was not one that had been acquired accidentally, but was the result of an imperfect response of the vegetative life to the particular environment; and while a continuance of the accustomed mental efforts may be conducive to a healthy will-power, nature admonishes her to seek a broader physical life, and to minimize the effects of artificial surroundings by spending a larger portion of each year in closer communion with itself.

CHAPTER IX.

MENSTRUAL DERANGEMENTS.

MENSTRUATION, essentially a neuro-vasculo-glandular phenomenon, is probably more directly affected by electric applications than any other function of the body. Demanding a certain equipoise of the nervous elements constituting the aptly named "abdominal brain," the inevitable result of currents so applied as to affect these nerve-structures is the regulation of the function when deranged in any way, particularly when the flow is aperiodic or deficient in quantity or quality. The condition present in many cases is essentially of a neurologic nature, requiring methods of a nerve-stimulating character, rather than strictly local or cataphoric applications. Where the derangements are, on the contrary, accompanied or caused by physical changes in the uterus or adjacent organs a method aiming at correcting the local conditions is essential. Owing to the nerve-relationships of this function, it will be found that any extensive electric treatment of any portion of the body, at or near the menstrual molimen, will tend to increase or hasten the flow, and particularly is this true of intra-uterine constant current treatment, during which it is well to warn the patient of this peculiarity. Where no abnormality of menstruation exists, therefore, it is well to intermit general electric treatment of any character during the period, unless, indeed, it is desired to increase its duration or amplitude.

Amenorrhea. — In the irregularly appearing, deficient, or suppressed periods of young girls just entering womanhood the abdomino-dorsal application of either the constant or induction current, negative to abdomen, is particularly indicated (preferably the former), the slight exposure of the person freeing it from objections inherent in any other method. It is, of course, incumbent on the physician to inquire closely, so far as possible, into the causes of the irregularity, and to institute additional means for their removal. Sedentary habits, overstudy, deficient assimilation of food, and particularly auto-intoxication from accumulated excretions within the intestines will most often be found to be the causes that lead to irregularity in the development of the sexual organs, and these must receive appropriate attention. In certain cases, however, the suppression occurs in otherwise healthy and even robust individuals as a result of mental or climatic influences or a change of environment, as when a girl removes from the country to the city or goes on shipboard to a new country. I have even noted such irregularity in the case of a girl who went south from Philadelphia to a more rural section. In the former case electricity should be conjoined with the other indicated remedial procedures; in the latter it will be sufficient alone, as the nervous system is mainly at fault. Whether the suppression be due to a general debility or to a mere disarrangement of the nerve-forces, a stimulation of the neuro-vascular processes in the pelvis is most beneficial. The current should be thoroughly applied to the abdominal and pelvic sympathetic plexuses and to the lumbar enlargement. The patient lying upon the large pad, the round pad should be applied alternately to the epigastrium and hypogastrium, from 50 to 100 milliampères being employed. There are very few cases, indeed, that resist strong currents thus applied, though vaginal and intra-uterine applications may exceptionally be required as a still stronger stimulus to the nervous processes of the pelvis. The active pole in the latter applications should invariably be negative, on account of its marked congesting, stimulating, and moisture-attracting powers.

Not a little of the benefit derived from the external applications in these cases is due to the correction of the constipation and imperfect chylopoiesis, which is usually responsible for the condition.

Scanty Menstruation.—If electricity at times is only an adjuvant to tonics and laxatives in the amenorrhea of delicate girls, it may, on the other hand, be regarded as an all-sufficient reliance in the scanty menstruation of mature women. This latter condition is frequently associated with neurasthenia, both in women of slight build and in those who are becoming too fleshy. The normal tidal wave of functionation is deficient in both, resulting in an irritability of the nerves that renders the patient miserable for a week or more in each month, or else permits her to take on fat by an accumulation of reserve material that would otherwise be thrown off, as suggested by Lapthorn Smith. In these cases we may employ simple bipolar induction currents from the fine wire to the uterus or vagina as a nerve-stimulus, as recommended by a number of writers, or the negative constant current to the vaginal surface of the uterus or to the cavity as I usually prefer, employing from 10 to 20 milliampères. A good plan is to alternate the constant and induction applications, the former being applied every five days.

Both currents are indicated in the attraction of blood and nerve-force to the pelvis, and some patients will quickly notice a relief in the symptoms of cerebral fullness and discomfort, which they rightly attribute to the scanty flow, even before the appearance of the next period. From what has been said of the effect of any electric application on the period it will be seen that this treatment should be continued until the actual appearance of the period, and may even be applied after its appearance, to intensify the effect.

A striking illustration of the effect of an increased flow on the nervous system was observed in my practice recently in the case of a lady who had suffered from cerebrasthenic symptoms for several years, associated with nervous dyspepsia, scanty menstruation, and sterility. The uterus was retroverted, but otherwise healthy. Complete relief of the gastric symptoms did not relieve the monthly accession of irritability until treatment was applied to the pelvis. One negative intra-uterine application a few days before each period brought on a satisfactory flow with the desired relief.

Menorrhalgia.—*Menstrual Pain; Dysmenorrhea.*—The list of pathologic views that have been advanced in accounting for what is usually called dysmenorrhea is somewhat extended, even when the term is restricted to the uterine type of painful menstruation, excluding ovarian and inflammatory pains and true neuralgia. Those most prevalent at the present time are, on the one hand, the mechanical theory of obstruction from stenosis or flexion, which may be called the Marion-Sims theory, and, on the other hand, the parametritic theory of Schultze. As to the first, it is not sufficiently well known that this latter observer has completely upset the obstructive or mechanical theory by demonstrating that a sound may be passed during the crisis of a supposed example of accumulation without encountering fluid: an observation which I have verified on a number of occasions. In several instances in which I have made intra-uterine applications during great pain the cervical canal was found to be not only free from contraction, but distinctly more dilated than at other times. The obstruction theory is also weakened by the examples of stenosis and anteflexion that occur without painful menstruation. Yet Schultze's theory of parametric or perimetric inflammation as a cause is not by any means satisfactory. That it has failed of practical acceptance by those even who advocated it is shown by their adherence to dilatation as a means of cure.

In that excellent picture of painful menstruation contributed by W. Gill Wylie to the "American System of Gynecology" another pathologic condition is suggested: hyperesthesia of the endometrium. That an hyperesthetic condition of the cavity does exist in these cases I think anyone who has passed a sound into them will admit. The exclamations of pain when the internal os is passed are most characteristic, and, in cases where a proper gentleness has been observed, must be other than normal; yet there are certain facts which indicate that hyperesthesia is but one of the conditions present. In a typical attack of painful menstruation the first thing to appear is the pain, which precedes the flow by an appreciable interval. How a mere hyperesthesia of the endometrium can explain this does not appear clear. In the great majority of such cases the pain ceases, in part or altogether, after the flow has been established, and it is this fact particularly which has intrenched the believers in the purely mechanical or obstructive nature of the trouble, which, in its boldest form, attributes the pain to a damming up of the menstrual fluid by a too narrow outlet, through which it is forced by a "mimic labor." To Schultze's demonstration of the absence of an accumulation, which is corroborated by an absence of dilation above the alleged stricture, may be added another argument against this latter view, in the fact that analogous conditions of stricture, as in the male urethra, are not attended by premonitory pains, but by greatest pain during the actual flow. The "mimic labor" illustration is inappropriate for the same reason. Finally, the nonexistence of a fibrous mechanical stricture is proven by the fact that ether will relax the apparently stenotic internal os sufficiently to permit a large dilator to be inserted.

A better explanation of the etiology of painful menstruation is that which regards it as almost entirely a neuro-muscular phenomenon. The attempt at the performance of an important function while either the nerve-centers in the cord or the uterus itself are in an unprepared condition results in pain. If the trouble is in the uterus the pains assume a nature that the patients themselves have accurately described as "cramps." In a paper read before the Philadelphia Obstetrical Society, December 5, 1889, the author proposed for this condition the name of "menorrhspasm." That the spasm alone is the parent of the pain rather than retained excretion is more than likely, an associated sequence being an inhibition of the excretory act until relaxation has occurred.

Menorrhspasm, in brief, may be said to be a neuro-myotic storm of the uterine neuro-muscular apparatus, which renders the excretion of the menstrual fluid temporarily impossible. Its exciting cause may be either lack of development of the organ or morbid conditions of the endometrium, while its remote causes are traceable to all those influences in modern society which hinder the proper development of physical life in young women.

That a spastic muscular contraction, most noticeable at the internal os, usually accompanies the menorrhspasm is undoubted, and there is reason to believe that the contraction may be excited by the sound between the periods. The predominance of circular fibers at the internal os, which is clearly shown in the accompanying cut (Fig. 37) from Barnes's "Diseases of Women," offers a ready explanation of this.

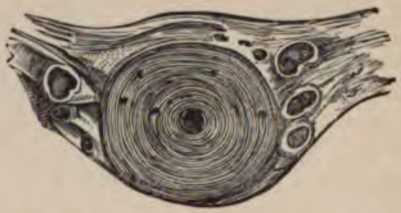


Fig. 37.—Section of Uterus made at Os Internum *(ad nat.)*, showing the Normal Size of the Os Internum, the Circular Disposition of the Fibers Around it, and the Blood-vessels in Proximity. (*Barnes.*)

If such views of this condition are correct, it becomes evident at once that a better name than "dysmenorrhea" (difficult menstruation) should be used in describing it, particularly since this term at once suggests mechanical conditions only, with the harsh treatment appropriate to such. At the meeting referred to, the author, while advocating the view that the causative condition was a menorrhspasm, urged the general use of the merely symptomatic designation, "menorrhalgia" (menstrual-flow pain) in preference to "dysmenorrhea," as, in itself, involving no theory.

Accepting the neuro-muscular view of the cause of these pains, the oneness of the pathologic condition in all cases is at once apparent, the difference being only a matter of degree. In the one case, the neuro-myotic storm is but a danger-signal pointing to a neurotic constitution, vasomotor disturbances, spinal irritation, abdominal torpidity, or even merely habitual constipation; consequently the attempt at the performance of a high function in the presence of these disabling conditions results in pain. Given a high degree of uterine neuro-muscular incapacity, and the spastic spasm occurs in the absence of these allied conditions, rendering direct local treatment imperative for its relief.

We have, then, a simple and convenient division of cases of menorrhalgia into those not requiring local treatment and those in which local treatment is necessary. The dictates of common sense unite with the high obligations of the physician in urging him to assign all cases of menorrhalgia in virgins to the former class, at least until he has demonstrated by a failure of general methods that a local examination is imperative. The author cannot too strongly condemn the general habit of hasty examination in these cases,—a habit that is a direct sequence of the ultramechanical views of the day.

For practical purposes a still further division of cases requiring local treatment is wise, since some cases are either due to, or accompanied by, catarrhal conditions yet confined to the uterus, while others present manifest congestion, inflammation, or other morbid conditions of the ovaries.

Nervous Menorrhalgia.—Menorrhalgia of the lesser degree, and even the most painful form, when accompanied by derangements of the nervous system or of the abdominal viscera and unaccompanied by organic uterine disease, is best treated by percutaneous constant current applications, abdomino-dorsal, or even merely spinal, the dose varying from 10 to 60 milliampères, *pro re nata*. Large, well-moistened electrodes, and the gradual manner, without shocks, should be employed.

In addition to many cases of pronounced menorrhalgia relieved by external treatment, I have a large number of instances recorded in my notes where young girls undergoing spinal applications of the constant current for different objects have volunteered the information that various amounts of menstrual pain had disappeared while under treatment. These cases generally improve in blood and weight also, but I have seen numerous instances where the lessening of the pain preceded any possible influence on the general health, being found in a period coming on but a few days after the beginning of the applications.

A systematic treatment of this sort should consist of thrice-weekly or daily applications, beginning at the termination of a period and lasting until the next flow has appeared. Two months of such treatment, combined with proper means for the regulation of the bowels, if such is required, will usually be sufficient to effect a permanent cure.

Uterine Menorrhalgia.—In spite of most careful treatment, nevertheless, many cases present a menorrhspasm of so pronounced a local character that nothing short of direct treatment will be of service. The frequent association of endometritis is also a determining fact in favor of local treatment. It is in these pronounced cases that dilatation has been of service, the possible explanations of its action including an alterative effect on the endometrium and the trophic condition of the organ, as well as the mere paralyzing effect of the divulsion.

In my experience a more certain and less formidable remedy for these intractable cases of uterine menorrhalgia may be found in the intra-uterine action of one pole of the constant current,—usually the negative pole when a promotion of flow is also desired, or the positive pole if the endometritis be pronounced,—the strength varying from 15 to 50 milliampères, *pro re nata.* From two to six applications may, at times, be sufficient, extending over one or two intermenstrual periods. As contrasted with forcible dilatation, this method is simple, free from danger, does not require an anesthetic, and may be employed in young girls without the use of a speculum. The following typical case may be cited as an illustration:—

Miss A. C., aged 24. Puberty at 13. Menstruation regular, normal in amount, and always extremely painful. No leucorrhea or intermenstrual pain. The menorrhalgia presented the usual characteristics, accompanied by hyperesthesia of the back and abdomen and pains down the limbs, and had been markedly increasing for the past six months. As she was constipated, a course of laxatives and lumbo-abdominal constant current applications was followed for one month without effect. Examination then revealed a small uterus with fundus forward, os virginal, and appendages healthy. After patient efforts an electrode was inserted to the internal os only, and 25 milliampères, negative, applied for two minutes.

Six days later the sound went to the fundus with but little trouble, and 40 milliampères were used. The ensuing period was less painful, permitting sleep for the first time in months during a menstrual period. The sound now entered with ease, and two more applications were made, followed by a perfectly painless period. Six months later the patient reported perfect health and continued immunity from pain.

Such a case is clearly an instance of lack of completeness in development, and it is very likely that induction currents would have been equally successful in the treatment.

But by far the larger number of cases of so-called dysmenorrhea, or menorrhalgia, are really instances of endometritis with menorrhalgic symptoms, and in these cases the ease of cure under electricity is no less an arraignment of the harsh methods of treatment by forced dilatation than the instances in which stenosis is one of the incidents of lack of development. Case after case has been sent to me after thorough dilatation has been fruitlessly used in which the only evidence of organic abnormality that existed at any time was a catarrh of the endometrium. When these cases can be cured by from one to a dozen applications without mutilating and cicatrizing the uterine mouth it is high time that such illogical procedures should be relegated to the obscurity of an historic fad. Certain electro-therapeutists even are not free from the influence of this disproven theory of obstruction, for they recommend electric dilatation with a series of graduated bulbs as the negative electrode. If there is any need of dilatation this is, of course, the typical method, but I myself never have occasion to employ any kind of dilatation in the treatment of these cases, unless the use of an ordinary sound-shaped electrode may be so called. Any cervical canal that can readily admit such an electrode is amply large for any flow, and the passage of clots is best treated by the cure of the causative endometritis. This statement of the required caliber of the cervical canal is not based on actual measurements, but upon the uniformly successful results of a large series of cases treated by electricity administered from an instrument of the same size (that of the Simpson sound) and without other dilatation than this instrument might produce. There has not been a single instance of failure to cure, though at times, in cases in which partial prolapse of the uterus or inflammatory conditions of the adnexa complicated the endometritis, the treatment has continued for many months, with finally a successful result.

A cervix with the characteristic pinhole os, with or without a contracted internal os, is unquestionably atresic, it is true, but this is only one symptom of a general sexual maldevelopment. A painstaking insertion of an ordinary electrode, assisted, at times, by 10 milliampères, negative, before it slips past the internal os, and the administration of from 15 to 30 milliampères, negative, will, if repeatedly employed, so lessen the hyperesthesia and increase the nutrition that the better developed uterus will admit the sound easily and almost painlessly, and painless periods will follow.

When the case is clearly one of virginal endometritis, of which the chief symptoms are the menorrhalgia and a leucorrheal discharge, the intra-uterine constant current treatment is indispensable, but the positive pole should be employed, with from 15 to 40 milliampères, twice a week. When the os is sufficiently patulous to admit an elastic electrode far less discomfort will follow its use than the stiff instrument, and it is even better to cover the bare surface of the spiral lightly with absorbent cotton dipped in hot water and soaped if the additional bulk will not be too great for its insertion.[1] At the end of the five minutes devoted to this current and before withdrawing the electrode an induction current should be turned on from a medium secondary coil, strong enough to be distinctly felt by the patient. The finger should always support the cervix at the moment of removing a cotton-covered electrode from the cavity, as it is apt to be somewhat tightly clasped by the uterus, causing the latter to be dragged downward. When the catarrh is confined to the body alone it is generally impossible to insert so bulky an instrument as a cotton-covered electrode, the folds of the cervical mucous membrane being capable of being eluded only by the painstaking use of the stiff instrument curved to suit the case.

The following typical cases illustrate the details of treatment:—

Miss A. D., aged 24, referred by Dr. Woodbury, gave a typical history of menorrhalgia with endometritis dating from puberty. External treatment failing to relieve her, an examination was made and the uterus found exuding considerable mucus, though small and anteflexed. The internal os was small and admitted the sound with difficulty. Twenty-five milliampères, positive, were given for five minutes on April 29th. Five days later 40 milliampères were given; on May 7th the flow came on several days ahead of time with much less pain. During the next intermenstrual period two applications of 40 milliampères, positive, were administered, and at the next ensuing period the patient was entirely free from pain or discomfort, and no leucorrhea followed it. No treatment was given this month, but the next period, being slightly painful, two more applications were made, resulting in a permanent cure.

---

[1] The appearance of the cotton after removal of the electrode will also be a material aid in diagnosing the condition and progress of the case.

Miss P., aged 22, was referred to me by Dr. Egbert H. Grandin, of New York, who had ineffectually used dilatation. Pain continued constant and at periods intense, requiring her to remain in bed. Examination showed an enlarged uterus, free leucorrhea, and tenderness of left ovary. She received six applications of 30 milliampères, positive, to the cavity during two intermenstrual periods, resulting in complete relief. Six months later she was well and gaining in flesh.

Miss R., aged 20, was referred to me by Dr. Bayliss, of Knoxville, Tenn. Since a delayed puberty at 16 she had always been menorrhalgic. The pain is worse after the flow begins, and during its height she "wants to die." A pain persists in the thighs between periods. On admission to the sanatorium examination showed the uterus, with the slight enlargement usual in these cases, tender and deviated to the right. A copious leucorrhea existed. She received intra-uterine applications of from 20 to 25 milliampères, positive, February 16th and March 5th, 14th, 20th, and 24th, accompanied by daily general constant current treatment for the nervous symptoms. The treatment was interrupted at this time by the patient's presence being necessary at home, and, though considerable improvement persisted for a time, there was a return of leucorrhea, with some pain, a year later. The result would, doubtless, have been perfect had stronger currents been used, assisted by local induction treatment.

Miss S., aged 20, had for several years had an increasing leucorrhea with a menorrhalgia that was becoming worse. The uterus was normal except for a muco-purulent catarrh and hyperesthetic cavity. Five applications of 30 milliampères were made to the cavity, resulting in a perfect cure, verified by ten years' subsequent observation. One of the earlier applications was made during the early hours of a period and the interesting fact observed that the uterus was more patulous than usual at the beginning of the flow in spite of intense cramps, thus adding another proof that the pain in these cases is not due to obstruction.

Miss H., aged 25, admitted from Wilmington, Del. This young lady was much reduced in health by a moderate uterine catarrh with menorrhalgia that had kept her in bed one day of each month for ten years and in an exhausted condition one week in each month for some time. The softened, eroded os and enlarged uterus required the touch only to establish a satisfactory diagnosis. The treatment was with both currents intra-uterine, the constant current usually being 35 milliampères. The use of cotton on an elastic electrode was practicable, and the progressive improvement was well shown by the gradual improvement in the appearance of the cotton after removal, the earlier applications leaving it saturated with bloody mucus. The cure was complete, and attested by quite a change in her appearance.

It has been my fortune to have had under similar observation and treatment many other cases of the same character,[1] and it is not too much to say that they were all surely rescued from a slowly impending invalidism for which an unsexing operation would have been advised when the tubes and ovaries had become involved.

Ovarian Menorrhalgia.—So much for the neural and uterine forms of menorrhalgia. But it should be understood that some cases are distinctly ovarian in origin, and by this is meant that the process described, of a neural predisposition and catarrhal aggravation, has proceeded so far as to finally involve the ovaries in organic changes,—usually of a merely congestive character, but none the less organic. In these cases any intra-uterine treatment should be carefully avoided and reliance placed on the applications described elsewhere for ovarian congestion or ovaritis. Such cases may be detected by noting that the patient has an intermenstrual tenderness, and on examination presents the characteristic bogginess in the ovarian regions. Yet it is not always possible to clearly distinguish between the cases that are of uterine origin and those in which the ovaries are involved, for the evident reason that the uterine seat of the trouble frequently persists after the case has developed ovarian symptoms from neglect or rash treatment, and in this predicament we must rely mainly on the vaginal applications recommended in ovaritis and salpingitis, interspersed with such gentle intra-uterine applications as the progress of the case will warrant. The following case is a good illustration of this difficulty:—

Miss ——, aged 18, had been dilated one year previously by a prominent surgeon, under ether, she having entered a hospital for that purpose. This not only failed to relieve her, but apparently transformed a simple uterine menorrhalgia into an ovarian menorrhalgia, since there had been a constant intermenstrual pain since the operation which she did not have before, and under which her general health was breaking down. She was placed on vagino-abdominal applications of both currents until the intermenstrual pain should be controlled, which did not occur for at least three months. During this time there was little or no abatement of the menorrhspasms themselves in spite of a general restoration of health. Intra-uterine positive applications of 25 milliampères were now made three times a month, with complete cure after three additional months. This lady has since married a professional colleague, has been safely delivered of a son, and remains in excellent health.

---

[1] For a study of fourteen cases see American Gynecological and Obstetrical Journal, page 201, February, 1896.

Menorrhagia and Metrorrhagia. — An inordinate flow at the periods, if persistent, is usually due either to an endometritis, to retained shreds of tissue from a miscarriage, or to neoplasms. When due to either of the latter causes, the flow partakes of the character of a metrorrhagia, and may appear between the periods or even be constant.

There are, nevertheless, a sufficient number of instances of simple menorrhagia unaccompanied by leucorrhea in young girls, evidencing laxity of tissue and vasomotor disturbance. Internal medication and hygienic regulation is usually indicated in these, and is ordinarily successful. There is also a type of persistent menorrhagia without leucorrhea in married women, of what might be said to be an uncertain origin, in which the intra-uterine application of the positive pole is urgently indicated. The following case is an excellent example of this:—

The wife of a clergyman, aged 29, was referred to me by Dr. G. H. Whitcomb, of Greenwich, N. Y., with the statement that she had been greatly relieved of pelvic tenderness and uterine fixation by the use of electricity in his own hands. She had been menorrhalgic for some years before marriage, which had occurred five years before seeing me, and had never been pregnant. Of late the pain had become excessive and the flow very profuse, requiring her to keep in her bed during the period. There was no leucorrhea.

Examination revealed a slightly enlarged uterus in good position and moderately movable. The cavity, within which a sound was inserted with difficulty, was capacious and three inches deep. She was placed upon intra-uterine applications of 20 to 30 milliampères, positive, followed by the secondary current, alternating with vaginal applications of from 50 to 60 milliampères. She did well on these when not too frequently applied, and after a half-dozen treatments was much improved. The intra-uterine applications were now continued exclusively, once a month, as the lady had removed to a town some distance from the city, ten such treatments being given during the continuance of a progressive improvement. The treatment was finally terminated, much to our common surprise, by the evidences of pregnancy, which went on to a happy termination. The patient has since passed successfully through two other pregnancies.

This case was under treatment prior to my discovery of the value of zinc-mercuric cataphoresis in hemorrhagic conditions of the uterus. A cure could undoubtedly have been obtained by this method in one-half of the time, or possibly less.

The electric treatment of persistent metrorrhagia from causes local to the uterus, of whatever nature, is one of the most valuable procedures introduced by Apostoli, and it is extremely rare to find a case that will resist the thorough application of the positive pole as directed by him. An essential feature of his method as applied to an intractable case is the instruction given that every portion of the endometrial surface should be placed in contact with the electrode in order that the peculiar hemostatic action of this pole should be made to reach all portions of the bleeding surface. The immediate effect of the positive pole thus applied is distinctly hemostatic, as may be demonstrated under the eye in any superficial bleeding surface, but it is also necessary that the secondary alterative effect of the mildly escharotic action should be secured in all portions of the mucosa of the uterine body. In order that this may be properly accomplished Apostoli advises that bulbous electrodes of carbon be used, the active surface being two centimeters long and of various sizes, in order that the physician may select the largest size that can be inserted. The one selected is carried to the fundus attached to the positive pole of the battery and a current of 50 to 80 milliampères turned on for two minutes; the current is then turned off and the instrument withdrawn to the length of the active surface, which may be easily ascertained by the finger at the os if the shank is marked at appropriate distances, and the current again turned on and the instrument kept immovable for another period of two or three minutes. This procedure is repeated until the bulb impinges on the internal os. The cervical cavity itself should not receive an application in ordinary cases. A most important feature of this treatment in an intractable case is that the electrode be held immovably at each sectional situation for a sufficient time to insure thorough local action. This will seldom require more than two minutes' duration at each spot.

The author has greatly improved on this method by substituting amalgamated-zinc bulbs for those made of carbon (Fig. 33), permitting less current to be equally effective, and the application becomes, moreover, thoroughly antiseptic. No other change in the details is made. The particular value of this addition to the Apostoli method is well shown in the following typical case:—

Mrs. ——, aged 54, was referred to me by Dr. H. W. Elmer, of Bridgeton, N. J., April 17, 1894. For three or four years before admission to the sanatorium she had been suffering from an almost continuous hemorrhage, resulting in great prostration. Shortly after the beginning of the hemorrhages a tumor of the uterus was discovered, which was the size of a large fist when I first saw her. She was placed under the Apostoli treatment, which produced considerable improvement in the hemorrhages, but did not, even after several weeks' active and six months' occasional treatment, entirely correct the hemorrhagic tendency. Fearing that the case was a malignant one in spite of the absence of marked pain, I decided to substitute an amalgamated-zinc electrode for the carbon one previously employed. It was found that the applications with this electrode were better borne, enabling them to be used more frequently. Six applications were made in a period of two weeks in December, 1894, completely checking the dribbling, and since then there has been no real hemorrhage and the patient has been restored to health. The tumor was materially reduced in size.

CHAPTER X.

CATARRHAL AFFECTIONS OF THE UTERO-TUBAL MUCOUS TRACT AND THEIR CONSEQUENCES.

The Etiologic Unity of Uterine and Tubal Catarrh.—It is of the utmost importance, in estimating the value of a conservative treatment of these very common affections, to recognize the fact that the great majority of inflammatory conditions of the pelvis are primarily due to catarrh of the utero-tubal tract, the initial lesion being a catarrh of the uterus, and that the initial seat of the disease is apt to remain in a more or less active condition during the prevalence of the secondary affections in the tubes and ovaries. It is a belated recognition of this fact that has given rise to the prevalent practice among surgical gynecologists of amputating the uterus itself after subjecting the patient to successive operations for removal of one and of both ovaries and tubes without relieving the suffering. Were such cases placed on rational treatment for the initial lesion none of the operations would have been required, and a great multitude of women would be saved to their families and to a normal existence.

The strong words used on this subject of the wholesale removal of still curable ovaries and tubes in preceding works by the author received criticism in certain quarters, but have never been controverted. At the date of the present edition of this work it must still be said with regret that, though the published utterances of many writers have noticeably changed for the better, this reprehensible practice of destroying important organs without proper efforts to cure them is by no means on the wane.

The pessimistic attitude toward the curability of chronic uterine catarrh itself has even taken the shape of a denial by some authorities of the abnormality of this condition, a varying amount of mucous discharge being said to be natural with most women. This is physiologically incorrect, no really appreciable discharge being ever found in a healthy person except in association with erection. The degree of departure from absolute health is quite accurately indicated by the amount and character of a persistent discharge, which, though constitutional only in certain cases of anemic girls, in every other instance points to actual local disease if large in quantity or purulent, and is indicative of possible extension in the future to the tubes and ovaries. Chronic endometritis, in other words, not only leads to uterine hyperplasia, but to salpingitis and ovaritis by direct transference through continuity of structure. The most common diseases of the appendages are, therefore, catarrhal in origin and secondary to catarrhal inflammation of the uterine mucous tract, not even exclusive of tuberculosis and of ectopic gestation, both of which are probably invited and fixed by an inflammatory *nidus*.

For practical purposes, particularly for an intelligent application of electricity to the exact seat of the disease, it is necessary to continue the division of endometritis and metritis into several varieties, each presenting peculiarities of microscopic and macroscopic appearances and clinical history due to the histologic structure of the particular organ mainly attacked or to the state of life of the patient; but it should be stated at once and distinctly that the views now held by most progressive thinkers, and concurred in by the author, class all varieties alike as microbic in real character, and hence pathologically identical, except as varied by the particular microbe concerned, the local structure attacked, and the stage the disease has attained.

Beginning as a glandular proliferation due to the combination of a neural cause with the implanted microbic invasion, whether the latter be a common infection or a gonorrheal infection in a nulliparous uterus or similar invasions in the postpuerperal condition, the tendency is toward an extension of the process to the underlying parenchyma of the uterus, resulting in an abundant formation of embryonal cells in this situation at the expense of the muscular and connective tissues. The process does not advance along the ordinary inflammatory stages of abscess-formation, as in acute inflammatory affections, but, doubtless, owing to a more nearly balanced condition of warfare between the pathogenic microbes and the tissue-defenses, remains in the stage of parenchymal degeneration and proliferation for years unless adequate means be employed for its correction.

The natural history of the affection as manifested in the uterus is therefore divisible into three stages, more or less distinctly separable by their clinical evidences, the first stage being a simple endometritis with leucorrhea, but without interstitial hypertrophy; the second stage showing both leucorrhea and interstitial hyperplasia, the latter often presenting the physical characters of the "engorgement" of the older writers; while the final stage is one of hyperplasia alone without notable morbid discharges, ending in sclerosis and final atrophy of the muscular structure.

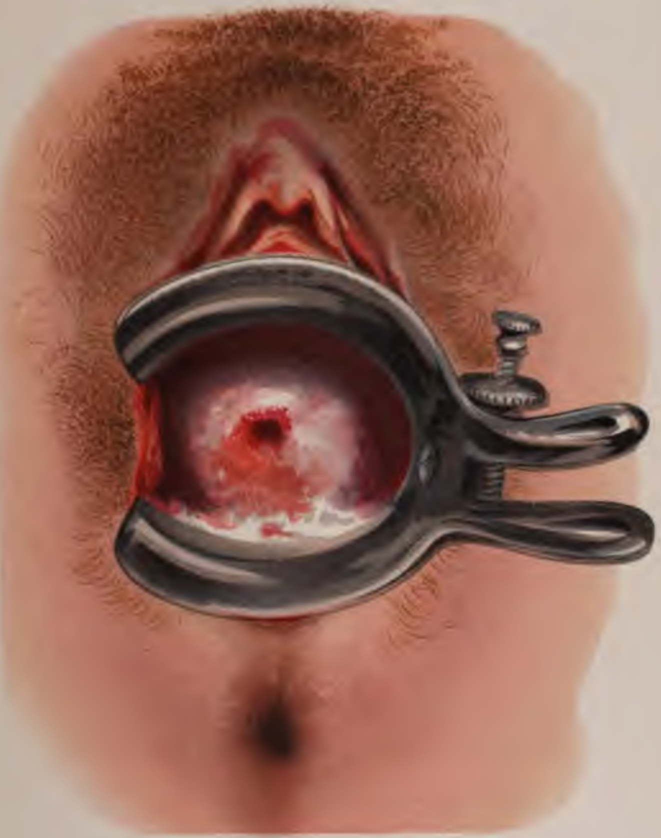
Diagnostic Value of Inspection of Persistent Uterine Discharges. —To the physician not engaged in the major surgery of gynecology only, the nature and characteristics of persistent uterine discharges are a matter of much importance. A large proportion of his cases are sure to be some form of utero-tubal catarrh which is invariably attended in some stage, and particularly in its more curable stage, by an abnormal discharge of some kind. That this discharge is only second to pain as a source of discomfort to the patient, and is a direct issue from the seat of the disease, are facts commanding attention; and our interest is increased when we recall additionally that a mere naked-eye study of the discharge will be of great value in enabling us to decide upon the propriety and exact character of the local treatment.

This subject of the character and source of persistent discharges formerly received much attention and was closely allied to the local treatment of those days, but it has had a setback for two reasons, one being that the earlier gynecologists had not learned to add to these lessons taught by visual examination of the secretions the invaluable assistance of a trained bimanual touch, which checks off and extends the information thus gained; the result was that the mind remained closed to important facts of upward extension of the conditions thus revealed by discharges, and applications were made to the uterus in the presence of salpingitis and ovaritis, which contra-indicated them.

The other reason for the recent neglect of the naked-eye appearances of uterine discharges as a means of diagnosis and an indication for treatment is the therapeutic nihilism of recent leaders in gynecology, who have apparently despaired of curing any form of metritis, and busy themselves with methods for extirpation of the organ. This is emphasized by the dearth of exact information in standard treatises as to the character of leucorrheal discharges, though it may be said that the work of Skene is a distinct exception in this respect.

As stated before, all catarrhal conditions of the utero-tubal tract are essentially only portions of the same disease, yet the evidences of a predominant seat of the chronic form of the affection in one or

PLATE X.



Chronic Leucorrhea of Vaginal Origin.

[illegible]

the other location are most important from a practical point of view, for their proper understanding enables us to apply curative agencies with great precision.

In Plates X to XVIII the author presents the first illustrations that have been published of the several varieties of cervical and corporeal discharges of persistent character, drawn and colored directly from nature. For this unique and novel series we are indebted to a rare combination of skill and patience in the artist, who spared no trouble and time in an effort accurately to portray on the spot the typical cases shown him.[1]

ENDOMETRITIS.

Cervical Endometritis.—In a state of health there are no appreciable discharges from either the uterus or vagina, save, of course, the menstrual flow and a slight mucous discharge which may precede or follow it, yet, while there is no *excretion,* there is, in a normal condition, sufficient *secretion* from the mucous membranes of these parts for the maintenance of moist conditions, and, doubtless, for bactericidal purposes, on the one hand, and the fostering of spermatic life, on the other. The normal secretion within the vagina is whitish, acid in reaction, and tends to collect within the folds and about the cervix in unmarried women as a white, curdy deposit (Plate X). The normal secretion within the cervical canal is clear, slightly tenacious, and alkaline in reaction. In a condition of chronic inflammation this secretion of the Nabothian glands of the cervix becomes more tenacious, viscid, and opaque (Plates XIV and XV). It is, at times, so tenacious that it is impossible to wipe it away with a cotton swab. When the stage of the affection is still purulent this viscid, stringy mucus is stained by admixture with pus-corpuscles, and its reaction is at these times acid.

This form of cervical catarrh is unquestionably more rare than the form to be described directly, and is thought, by the author, to be due to a profound microbic invasion of the Nabothian glands of the cervix from gonorrheal infection of long standing.

---

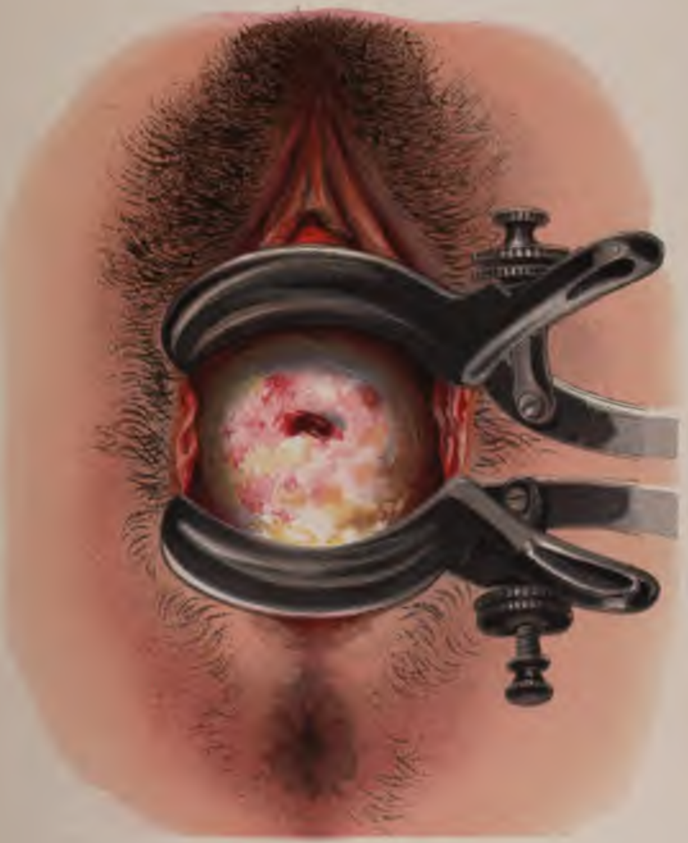
[1] The coloring of these drawings is vouched for as a correct picture of the typical cases selected, and, as some of the cases were drawn from patients at various hospitals, the artist was enabled to obtain a technical corroboration of the coloring from the physician in attendance in every instance. For clearness of illustration it was, nevertheless, necessary to represent the vagina as shorter than natural.

In the other form of cervical endometritis the most prominent symptom is the "granular erosion," which is found spreading from the external os over a varying part of the vaginal portion of the cervix in an area concentric with the opening (Plates XII and XIII). This was described by Bennett and the older gynecologists as "ulceration of the cervix." The true nature of this morbid condition has been ascertained by Ruge and Veit, in Germany, and de Sinety, in France, to be a morbid proliferation of the epithelium surrounding the external os, in association with a similar condition within the cervical canal. It is therefore usually not an ulceration at all, in the sense that a loss of substance exists, though this may be the case, but involves the singular fact that the cylindric epithelium of the cavity of the cervix is said to be reproduced outside of the os within the eroded area where pavement epithelium normally exists. Several explanations of this odd circumstance are given by recent writers, those of the surgical school holding that the condition is frequently produced by an eversion of the lining of the canal by reason of laceration of the underlying tissues of the cervix in parous women, or by a simple ectropion of the membrane by reason of its morbid redundance in nulliparas. As the condition is most frequently met with in women who have never been pregnant, the slight bearing of laceration on its production is, nevertheless, evident.

It appears to the author that these studies do but little to clear up the practical questions at issue, and that Tyler Smith's claim that the conditions observed are but secondary to a catarrhal endometritis within the cavity are substantially correct. That an eroded or possibly hypertrophied and altered epithelium without a catarrhal cavity may be produced by an acrid discharge from within it is well proved by the condition noted on the skin beneath the nostrils in neglected children with nasal catarrh, where a practically similar lesion may be seen. In some of these cases the erosion extends to the vaginal walls even, making the resemblance more perfect. If the two conditions are analogous the absurdity of treating erosions external to the os by direct applications to this surface alone is evident.

It is probable that this peculiar form of catarrhal invasion of the cervical cavity is due to a special form of pathogenic microbe, for observers have noted that the affection may involve the cavity of the

PLATE XI.



Chronic Purulent Leucorhea of Uterine Origin.

[illegible]

corpus as well as the cervix. That certain individuals are prone to contract it seems also established.

When the Nabothian glands are also affected there is a tendency to a closure of their ducts, producing shotlike cysts projecting from the surface, which may lead, by pressure atrophy, to extensive cystic degeneration of the cervix.

The constitutional symptoms of cervical endometritis are less marked than when the affection is generally disseminated through the whole organ, yet backache, a sense of weight in the pelvis, and often menorrhalgia accompany the leucorrhea.

In the treatment of these very obstinate affections mere applications to the surface will be ineffective for the reason already given, that the disease is situated deeply in the cervical mucous membrane. The most effective electric method is the use of mercuric cataphoresis, for here we have a penetrating microbicide and alterative that may be sent to any depth by interstitial diffusion. The zinc-mercuric method is probably as effective as the gold-mercuric, both being applied in the moderate milliampèrage of from 30 to 50 to the cervical cavity. When associated with moderate degrees of corporeal endometritis, as it often is, it is generally more expedient to employ the mercury on either a silver or copper electrode, owing to their smaller size and the possibility of properly shaping them to fit the cavity.

Illustrative Cases.—A young lady of 22, who had been suffering from menorrhalgia with profuse leucorrhea for three years, was sent to me from a neighboring city. As there had been considerable instrumental treatment, resulting in moderate dilatation of the introitus, a small bivalve speculum was inserted (contrary to my custom in virgins, as erosion is easily detected by touch alone), revealing erosion of the os and a softened and dilated cervix as far as the internal os. On inserting the sound the internal os was found to be normally tight and the cavity of normal depth. It was clear, therefore, that the affection was confined to the cervix alone.

As this case and the following one were seen before the development of mercuric cataphoresis, the treatment employed was positive cauterization from a bare platinum electrode inserted beyond the internal os and slightly withdrawn before turning the current on. The strength employed was 25 milliampères twice a week, followed by the induction current. At the end of six weeks' treatment, succeeded by two weeks' rest, her condition was materially improved, as to leucorrhea and the general symptoms, but the erosion remained little changed. The applications were now made once a week for two months, with a final relief from all symptoms and a better appearance in the eroded area. Just what the condition of the os is at present, some years since the termination of the treatment, is unknown, but the patient remains in excellent health.

Mrs. S., a married lady of 25, who had never conceived, presented symptoms similar to the last patient since her marriage, a period of three years. After much ineffectual treatment she applied to me in March, 1891. Her condition at this time was as follows:—

Her principal symptom was menorrhalgia, associated with scant menstruation and intermenstrual backache. Examination revealed erosion extending a half-inch in all directions from the os, with copious muco-purulent catarrh of a tenacious character. The inner os was small and the cavity, as a whole, measured but two and one-half inches.

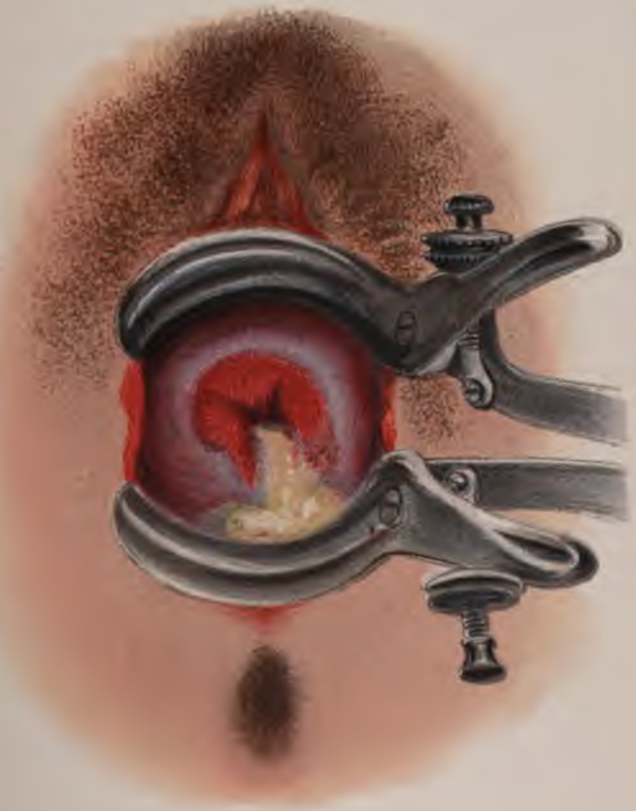
In spite of the scanty menstruation it was thought best to employ the platinum electrode with the positive current, beginning with 20 milliampères. The applications were made twice a week. The following period was free from pain and there was a great lessening of the discharge without any improvement in the appearance of the eroded area. After two months' desultory applications treatment was suspended for the summer, as she seemed practically well. In the fall the applications were renewed, owing to one period having been painful and for the purpose of curing the erosion, resulting finally in a complete restoration to health.

Miss R., a maiden lady of 40, had been in poor health for a long time, but complained principally of a copious purulent leucorrhea and pain in the upper spinal region. There was no menorrhalgia. Examination revealed an enlarged, softened cervix, with an eroded surface, which I was able to show to the artist (Plate XIII). Like the other cases mentioned, there were distinct evidences of noninvolvement of the corpus.

The treatment in this case was by cupro-mercuric cataphoresis, an ordinary nickel-plated sound being denuded of its plating by dipping it in acid, after which the stem was insulated with wax and the tip amalgamated by redipping in acid and then in mercury and rubbing it on moistened cotton. The strength of the current was 35 to 40 milliampères for ten minutes, repeated twice a week. At the end of two months there was a complete resolution of the eroded area as well as arrest of leucorrhea. She received appropriate medication for her general health at the same time.

Corporeal Endometritis.—Chronic inflammation of the cavity of the body of the uterus is characterized by an enlargement of this portion of the organ without participation of the cervix. This is readily detected by a comparison of the conditions found by simple touch with the enlargement detected by the bimanual touch, and particularly when we find the sound will go to a depth greater than the normal two and a half inches without the cervix participating in the enlargement. This condition is by no means rare, for it is liable to be found in all cases of chronic metritis due to subinvolution or to retention

PLATE XII.



Erosion of Cervix with slight Laceration.

[illegible]

of septic material,—in other words, whenever the condition has arisen independently of an upward extension from a previously inflamed cervix. The leucorrheal discharge in these cases is serous, whether it be purulent or sanguineous, and is therefore readily distinguished from the cervical discharge, though not so readily observed in the act of issuing from the uterus. The therapeutic management of chronic corporeal endometritis differs so little from that of the larger number of cases of general chronic metritis that further consideration of the subject is incorporated in the following paragraphs.

CHRONIC INFLAMMATION OF THE UTERUS WITHOUT EXTENSION TO THE TUBES AND OVARIES.

Chronic Metritis.—The clinical experience of the author has led him to the conclusion that either uterine catarrh or its consequences are responsible for the sufferings of a large proportion of the patients, married women in particular, who consult physicians for symptoms of obvious pelvic origin. Reference is made, of course, to cases of a chronic nature which, on examination, exhibit an enlargement of the unimpregnated uterus above the size natural to the state of life of the patient. Though such a condition may date from a puerperal subinvolution and the leucorrheal stage be long past, its dependence on an original bacterial invasion is none the less definite, for in an organ of this particular structure the active stage of inflammation represented by the bacterio-phagocytic contest occupies but a small part chronologically of the so-called inflammatory process, the tissue reaction evidenced in a proliferation of the connective-tissue cells becoming a far more persistent feature. The stubbornness of an analogous inflammation of the nasal mucous membrane is quite familiar. The persistence of a catarrh of the uterine mucous membrane is even more likely, for the membrane in this case overlays a tissue more open to invasion, and subject to the periodic congestions of menstruation and pregnancy.

Clear views of this nature are exceedingly important from a therapeutic point of view, and will displace from serious consideration many minor mechanical faults of the uterus to which too much attention has been paid of late. Versions, flexions, and even moderate lacerations of the cervix become of secondary importance in a still movable uterus which is the seat of this trophic disorder. The versions and flexions are, in fact, often due to the interstitial changes within the uterine wall, either from overweight or unequal distribution of the morbid process to one aspect or the other of the muscular fibers, while the healed laceration which, when it occurred, had opened the avenue of infection, will present no symptoms after the dissipation of the inflammatory process. To cut out such healed scar-tissue at this stage is like locking the stable-door after the horses are stolen.

Such a purely mechanical theory of uterine affections arose in the prebacterial age of medicine, and should be dispassionately reviewed in the light of this important addition to human knowledge.

The direct cause of all cases of chronic metritis is, of course, a microbic invasion made possible by a lessened physiologic resistance or a traumatism. The special microbe involved may be either the gonococcus, in which case *an acute stage must precede the one under consideration,*[1] or more ordinary pathogenic varieties which are always present in the vagina and cervix, but never normally above the internal os. It would seem that the inner end of the cervical canal was, under ordinary circumstances, an inner line of defense against such invasions by virtue of its secretions, and that no pathogenic organisms succeed in passing this point unless the defenses of the body are lowered by neural conditions or by traumatism.

A cumulative increase in a cervical endometritis, coupled with increased susceptibility, accounts for the upward invasion without traumatism.

Traumatism, as a cause of corporeal endometritis, which is but the earlier stage of parenchymatous metritis, includes the cases due to subinvolution, to the retention of septic remnants of fetal membranes after instrumental delivery or abortion, to laceration of the cervix, and to the harsh use of instruments.

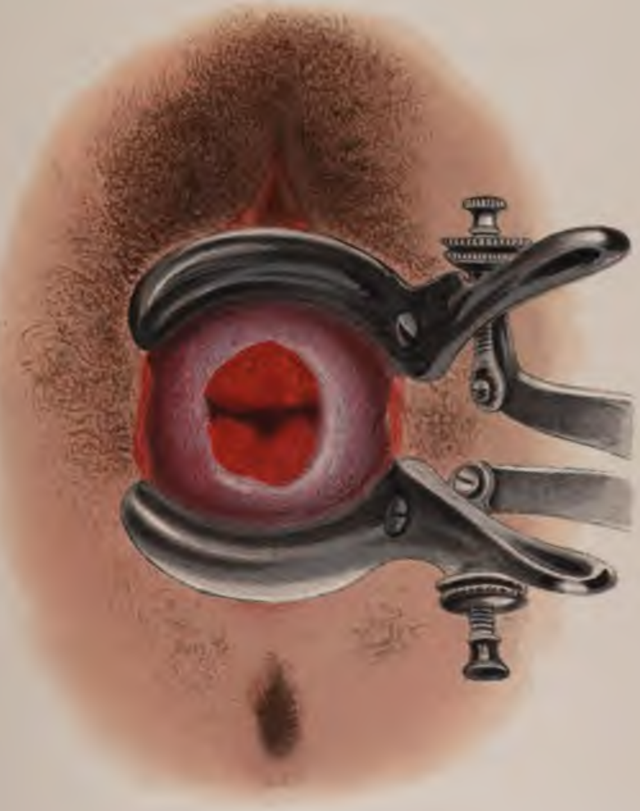
The term chronic metritis includes, therefore, a variety of conditions with widely differing clinical characters, depending on the nature of the tissues mainly attacked, as well as the stage of the affection and the character of the microbic cause.

From certain clinical points of view these cases of chronic metritis are divisible into two other classes that much resemble the divisions made by the late George M. Beard in cases of sexual disease in the

---

[1] The acute stage of gonorrhea in a woman may, nevertheless, be far less troublesome than in a man, as pointed out by Noeggerath, and not distinctly known to her as such.

PLATE XIII.



Erosion of Cervix.

[illegible]

male. In the one class the affection occurs as a purely local disease, the nervous organization of the individual being so robust that it fails to be affected by the local disturbance; in the other class a far less degree of local trouble may be found, associated with profound depression and disorder of the nervous system,—a disorder that, at times, seems greatly disproportioned to the local disease. On these reflex symptoms some doubt has been thrown of late, but the best proof that pains in the anterior crural region and in the back, with or without nervous prostration, are caused by this "irritable" uterus is given by the disappearance of such symptoms in a sufficiently large number of cases as a result of local treatment. The reason of the doubt may possibly have been a lack of neurologic training in certain gynecologists, who have mistakenly treated such diseases as hysteria, neuralgia, locomotor ataxia, and even scoliosis, in the writer's experience, as mere nervous manifestations of pelvic disease. The prevalence and ultimate discredit of the recent fad in which it was attempted to cure not only uterine inflammation, but many nervous diseases, by removing scar-tissue from the cervix, may also be partly responsible for this attitude.

In the first class of cases mentioned the treatment may be carried out in the office, but cases accompanied by nervous prostration are suited only to the salutary care of an institution in which both the local and nervous elements in the case will receive due recognition.

The Therapeutic Problem.—With full acquiescence in the belief that all forms of chronic metritis are essentially bacterial in origin, it does not follow that a microbicidal course of treatment is the only indication to be followed, notwithstanding its evident importance even in the latter stages. In these stages of the process a more important indication lies in the necessity for arousing and maintaining more vigorous trophic processes in the parts so long overwhelmed by foreign forces, for it should be understood that in place of the active inflammation we now have rather the *débris* of the bacterio-phagocytic contest to deal with, in the shape of interstitial exudations and proliferated connective tissue. The therapeutic problem involves a correction of these conditions and consequences, which, in the cases usually seen by the specialist, have become a far more important factor in the disease than the original microbic invasion.

The intra-uterine therapeutics of the day, such as the application of caustics and the curette to the interior of the uterus, have, doubtless, accomplished results mainly by arousing the full trophic activities of the part, but, as stated by Apostoli in 1887,[1] "the general reproach which may be made against all intra-uterine therapeutics adopted so far might be summarily formulated as follows:—

"1. It is brutal, blind, and may be dangerous in inexperienced hands.

"2. Its dosage is wanting.

"3. It is difficult to localize.

"4. It has a more or less instantaneous action, which ceases generally after its application.

"5. It is sometimes sterile, inefficacious, or fanciful.

"6. It treats the mucous membrane, but is wanting in direct action upon the parenchyma."

Induced by the success of his work with fibroid tumors of the uterus, Apostoli began, in 1883, to apply a similar technique to the affections under consideration, and subsequently affirmed its advantages in the treatise mentioned to be[2]:—

"1. An easy method which any gynecologist can execute alone and without help.

"2. A method which is mathematically dosable; which cauterizes much or little, according to the wish of the operator; and which is marvelously subject to a simple and precise graduation.

"3. Progressive cauterization, which is never instantaneous and which may be administered in fractional doses, the effects of which accumulate at the will of the physician.

"4. An active cauterization which may, if we desire it, go beyond the limits of the mucous membrane and of which we can easily graduate the extent and depth.

"5. It unites the galvano-chemic action contemporary with the passage of the current, and similar, according to the active pole, to that of acids or of bases, and a trophic after-action followed by a process of retrogression and certain disintegration.

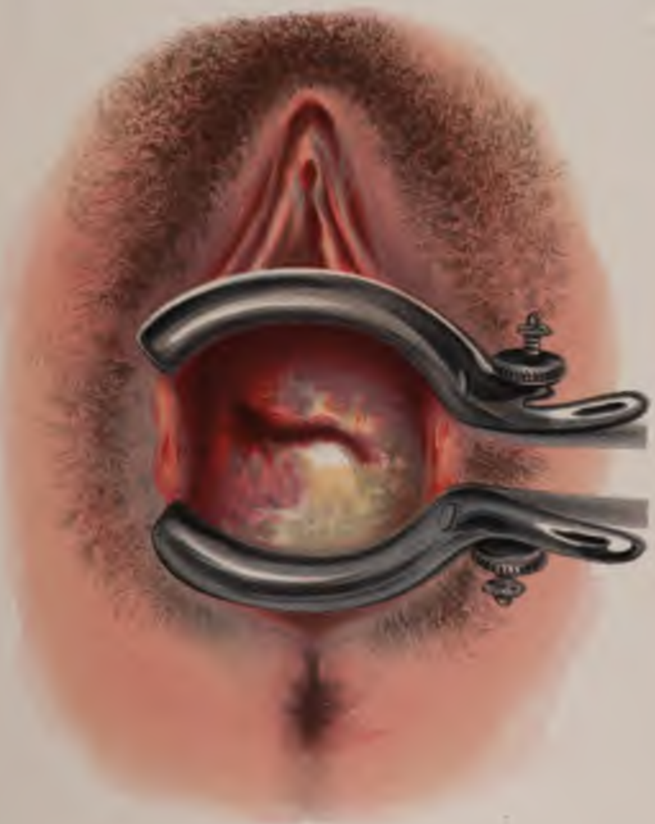
"6. A rapid method which offers every facility, according to the intensity of cauterization, to act with variable quickness according to the case.

---

[1] "On a New Treatment of Chronic Metritis," by Georges Apostoli. Translated by A. Lapthorn Smith, Detroit, 1888.

[2] *Ibid.*, page 52.

PLATE XIV.



Cervical Endometritis (Early Stage.)

[illegible]

"7. Absolute harmlessness of the medication, which is made in an aseptic manner and without harshness.

"8. Possibility of localization in a case where we do not wish to effect more than a limited extent of the uterine mucous membrane.

"9. A weapon with a double edge, which, according to the pole in action, is able to give either a hemostatic effect or produce congestion by attraction of moisture.

"10. A cauterization which is antiseptic itself on account of the energy of the released ions of electrolysis.

"11. The application is little, or not at all, painful, and does not require anesthesia."

The general directions given by Apostoli were in harmony with the known actions of the two poles of a constant current,—namely, that the positive pole was to be used in hemorrhagic conditions and where a microbicidal effect was particularly desired, while the negative was reserved for hyperplasia alone.

A personal experience that has been by no means small has convinced me that these claims of Apostoli have been fully justified, both from the point of view which requires that the galvano-chemic process be used as a controllable means for the destruction of the morbid mucous membrane, and from that in which reliance is placed on the arousing of trophic activities by less currents applied on covered electrodes. By the process which I have introduced to the profession, in which mercuric salts may be cataphorically applied to the uterine surface and parenchyma, I have, moreover, made it possible to obtain even quicker results in resolution of the morbid process and absorption of the redundant cell-tissue without true cauterization, for in this process the cauterizing oxygen and chlorine are absorbed by the mercury. This method necessitates the use of the positive pole, but is specially adapted to conditions requiring this polarity, and its employment will not only prove to be superior to all surface medication of the endometrium, but render curettage unnecessary except when bulky *débris* exists within the uterus.

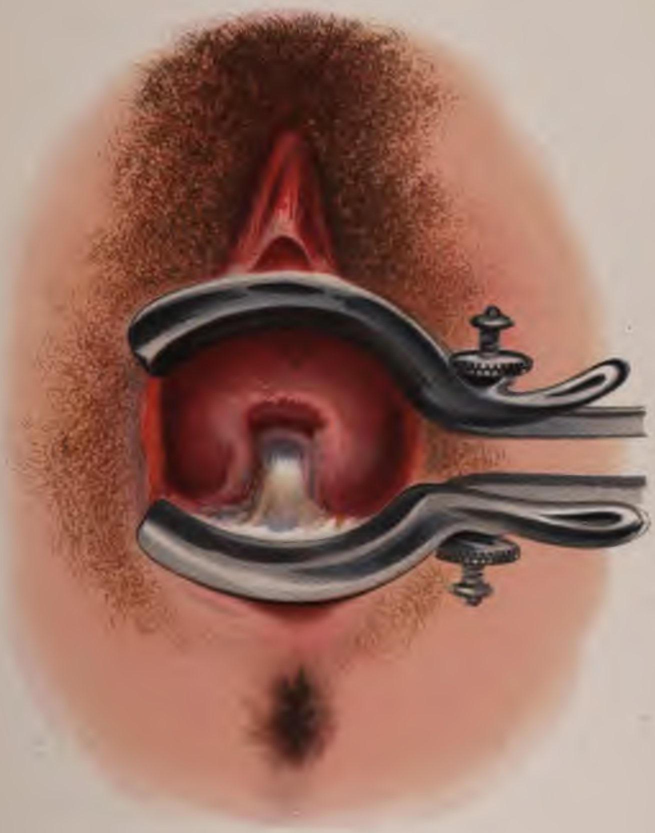
The effect of these relatively strong intra-uterine applications upon fertility deserves consideration. In a series of thirty-two cases reported in a paper before the American Electro-Therapeutic Association, in 1894,[1] I was able to ascertain that six cases had become pregnant since the termination of the treatment. At the same meeting Apostoli contributed a paper also, in which he reported eighty cases that had become pregnant after electric treatment. The proportions reported by me are, of course, not matters of definite ascertainment since a considerable number of the cases treated were not married, and many instances of pregnancy have, doubtless. occurred among the cases treated without the knowledge of either observer. Considering, however, that the greater number of all these were unquestionably sterile at the beginning of treatment, on account of the morbid conditions of the mucous membrane and its discharges, it would seem that the effect is to increase the fertility.

---

[1] See Transactions of the American Electro-Therapeutic Association, 1894, page 78.

Postpuerperal Metritis; Neglected Subinvolution.—Arrested involution of the postparturient uterus, whether due to inertia, non-traumatic infection, or traumatic infection, is more successfully and quickly treated by electricity than by any other means at our disposal. It is even a question whether normal involution would not be materially hastened by the systematic application of induction currents to the highly contractile tissue still constituting the bulk of the uterus, as advised by Apostoli. Certain it is that when the natural process is sluggish by reason of a diminished rate of shrinkage in the muscular fibers a few applications of the induction current from the primary or a coarse wire secondary coil will stimulate the flagging muscular tissue to develop its normal tone. Sanguineous discharges continuing beyond the normal periods of their appearance, or recurring during the first month after parturition, may be controlled by one or two such applications; and if there is no sepsis or traumatism as a causative factor, no other treatment is necessary. Either the monopolar or the bipolar method may be employed, but the primary current is preferable. But it is rare for subinvolution to be of so simple a nature,—shreds of retained decidua, a morbid condition of the endometrium, a laceration or other trauma, being the determining causes of a septic endometritis to which the subinvolution is due. In these cases the constant current is indicated with the simple positive pole or with zinc-mercuric cataphoresis if the hemorrhagic feature predominates, though in simple cases the covered elastic electrode is best on account of giving the least pain. The swelling method (gradually increased and diminished currents) should be employed, with a dosage varying from 25 to 60, or more, milliampères. To this the induction current may also be added.

PLATE XV.



Cervical Endometritis (Late Stage.)

[illegible]

For a septic condition of the uterus the positive mercuric pole is the most satisfactory, owing to its distinct bactericidal powers, and, if the foul discharge comes from only small shreds of retained membrane or clots, it is quite unnecessary to resort to the risks and loss of blood attending the use of the curette. The drainage that follows a constant application will usually be amply sufficient to carry off these shreds when detached by the action set up by the current; but if the placental remnants be large and abundant the dull curette should be used before the alterative and contracting applications are made. In the author's opinion, the sharp curette should be abandoned altogether, as its indications are better met in every case by the constant current alone.

Hemorrhagic Metritis.—This condition is either due to the retention of shreds in neglected subinvolution or to a vegetative hypertrophy of the mucous membrane of the body (adenomatous endometritis), or finally to hemophilia. Its treatment, except when due to the last-named condition, yields the most accurate and successful results in the whole range of electro-therapeutics. The writer has never had a case fail to respond promptly to the proper use of the positive pole of the constant current, after the method popularized by Apostoli, in which sectional electrodes are used for the purpose of cauterizing the entire mucous membrane of the cavity, step by step. Since the adoption of a mercury-coated zinc electrode, however, he is convinced that time may be gained by its use in place of the carbon instrument. The first applications with any kind of electrode are, nevertheless, likely to induce bleeding, which lessens in amount with each subsequent application. The instrument should always be bare, and the current-strength may vary from 50 to 100 milliampères, according to the obstinacy of the case.

It is important to note that the applications should never be made during a menstrual period, if the bleeding is not continuous. It is usually possible to distinguish between the intermenstrual period and the menstrual flow even in a case that presents continual dribbling. In the latter case an exception may be made for a few applications in the rule of a five-day interval between intra-uterine applications, which are made every other day for a time. The largest electrode that can be inserted should be used.

Hyperplasia of the Uterus, With or Without Cervical Laceration.—It is by no means rare for the clinician to encounter cases which, presenting the nervous symptoms of chronic metritis related above, reveal, on examination, an enlarged uterus without notable discharge from the cavity. The uterus, as a whole, may be enlarged, but the hypertrophy is generally limited to the corpus alone, which is indurated, usually retroposed or retroflexed, and only moderately fixed if the appendages are healthy.

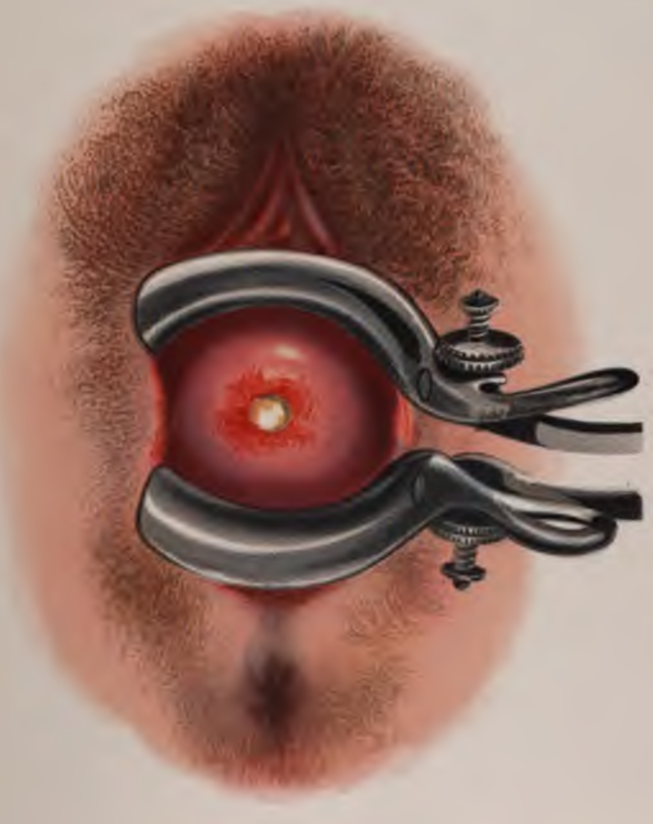
Such cases are instances of the later stages of chronic metritis, and will usually give a history of more or less discharge at an earlier period. The cervix, in many such cases, will show a healed laceration, showing clearly the avenue by which the infection originally entered.

It is in this class of cases that Emmett's operation of trachelorrhaphy has been most frequently performed, and some of my cases were instances in which the operation had already been done, without relief of the symptoms or material lessening of the abnormal bulk of the organ. It is, of course, conceivable that this operation may result in a lessened bulk of the uterus by its derivative and revulsive effects, though erroneously performed in a belief that the healed tear was a source of the symptoms; but this is rare excepting when the cervix participates in the hypertrophy.

The true lesion in these cases is unquestionably a degeneration of the muscular substance of the uterus and its replacement by embryonic tissue of sluggish vitality. The ideal treatment is, therefore, one which will stimulate metabolic activities, promote absorption, and favor regeneration of the muscular fibrils. Nothing can equal the negative pole of the constant current for these purposes, assisted by concurrent applications of the contracting induction current (from either the primary or a course-wire, secondary coil). The constant current is, by far, the most important portion of the electric treatment, and should be applied in appropriate dose.

Illustrative Cases.—Mrs. M., aged 31, an excellent instance of the class mentioned in which the general nervous system had resisted the effects of pelvic disease, was admitted to the sanatorium from a neighboring city. The uterine trouble from which she suffered dated from her first confinement seven years before, and was aggravated by each of two subsequent confinements, the last having been eighteen months previously. She complained of sacral aching and a dragging sensation in the pelvis which was aggravated by the erect posture and by walking, rendering her particularly miserable in the evening. Menstruation was regular, but scanty, and the alimentary functions were normal. There had been a history of considerable leucorrhea, but none was now complained of.

PLATE XVI.



Gonorrheal Endometritis (Early Stage.)

[illegible]

Examination showed an enlarged, retroverted uterus with an eroded os and a cavity four inches in depth, exuding inspissated mucus. A spot in the rear of the uterus was extremely tender. She had been wearing a Smith-Hodge pessary, which was removed. Treatment was begun by vaginal alternatives of the constant current and the secondary induction, but it was quickly changed to covered negative intra-uterine applications of 30 milliampères in view of the absence of disease of the appendages, alternating with the vaginal applications. In five days there was a decided relief of soreness; but it was necessary to continue treatment six weeks in the house, followed by several months' office treatment at intervals before complete symptomatic cure. At this time the uterus was normal in size and depth and but slightly retroposed. The completeness of the cure has been tested by five years' observation and one pregnancy without relapse.

Mrs. P., aged 33, was sent to me by Dr. Oaks, of North Ridgeville, Ohio. This case was a good example of the second class of cases mentioned, where uterine disease reacted unfavorably on the nervous system in connection with other depressing agencies. She had been married but four years; but had been in bad health since four years before marriage, which had been sterile. The beginning of the trouble was clearly in a virginal endometritis with menorrhalgia dating from puberty, and the gradually increasing uterine involvement had been assisted by a neuropathic heredity and the strain of nursing a sick mother. The pain continued very severe at the periods, with scanty flow, and there was vaginismus and dyspareunia. She complained of a neuralgic pain "all over the body" that was most distressing at night. Examination showed the uterus enlarged, retroflexed, adherent, and very tender. The cavity was three and one-half inches deep and exuded considerable muco-pus. The patient was placed on a six weeks' course of intra-uterine negative applications of 20 to 30 milliampères and the rest cure with general electric stimulation, and very shortly showed an improvement in both local and general symptoms, followed by an ultimate restoration of health.

Mrs. C., aged 26, applied for treatment, complaining of weak back and pain in the pelvis. She had never been pregnant, and the leucorrhea, which had lasted for four years, was clearly traceable to one or more attacks of gonorrhea. The uterus was but slightly above the normal size, yet tender and exuding abundant muco-pus. She was placed on positive intra-uterine applications of 20 milliampères once a week and negative vaginal applications twice a week. Pain was shortly relieved, and by the following month the leucorrhea had been controlled.

Senile or Atrophic Metritis.—The importance of this form of metritis has been particularly shown by Skene.[1] It may be resultant from a purulent endometritis of earlier years that has been neglected or it may be developed after the menopause. By reason of the lowered vitality of the senile sexual organs this affection is unusually intractable to ordinary methods of treatment, the ulceration of the mucous membrane resulting in its ultimate destruction and of the tissues beneath it also at times. The resemblance to carcinoma is very great in the later stages of erosion, from which it can be clinically distinguished by the leucorrhea being muco-purulent or merely purulent instead of serous, as in cancer.

---

[1] "Medical Gynecology," page 489.

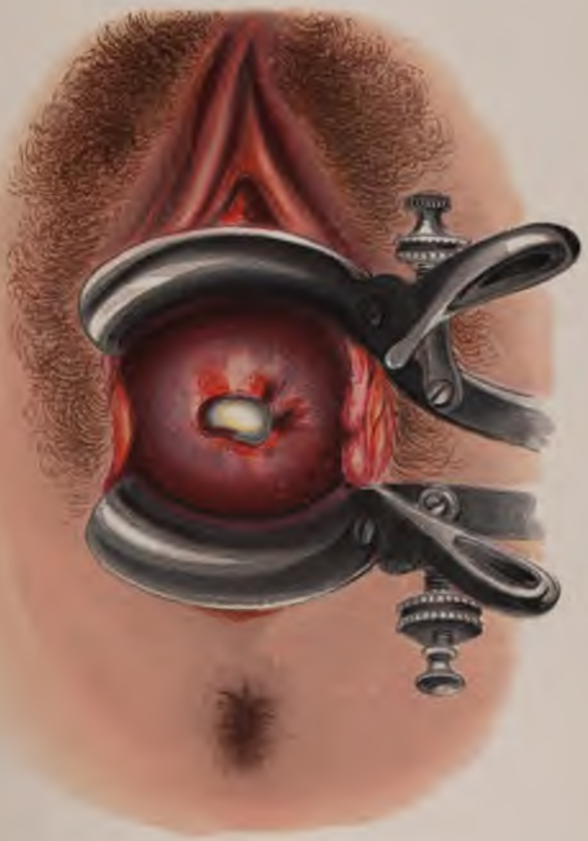
Goelet has recommended the negative pole of the constant current, but my own experience indicates that zinc-mercury cataphoresis is far superior owing to its noncauterant action and the specially helpful effects derivable from the nascent chemicals released. A smaller current-strength is, moreover, sufficient in the latter case, being proportional, however, to the extent and stage of the disease. From 20 to 50 milliampères applied to the whole of the affected surface twice or thrice weekly quickly removes all odor, and will result in a complete cure in several months.

CHRONIC INFLAMMATION OF THE UTERUS WITH EXTENSION TO THE TUBES AND OVARIES.

Metrosalpingitis.—Though it is rare for the physician to encounter an endometritis or metritis in an acutely active stage (unless due to gonorrhea or bad surgery), it is not unusual to be called in a case of acute or subacute salpingitis, either original or recurrent, and in such a case the judicious use of vaginal applications of the bipolar induction current at the bedside will not only replace opium and other sedatives largely, but materially reduce the extent and duration of the inflammation. Care should be observed not to cause pain either by the insertion of the electrode or by the current, which should invariably be from a long, fine, secondary wire and controlled carefully. The bipolar electrode should, of course, be warmed before insertion, as pointed out by Goelet, the patient lying at ease in bed and well covered, and the application should be prolonged for fifteen or twenty minutes. If distinct relief is experienced (and generally there is a pronounced relief of pain) the application may be repeated twice a day.

Among the conditions closely allied to chronic catarrhal metrosalpingitis and salpingo-oöphoritis are interstitial or parenchymatous salpingitis, purulent salpingitis, pyosalpinx, hydrosalpinx, hemato-

PLATE XVII.



Corporeal Endometritis of septic origin.

[illegible]

salpinx, and simple ovaritis, with or without prolapse of the organs. Each of these conditions is, of course, readily diagnosed during or after an abdominal section, but, as the desire of the conservative gynecologist is the cure of the patient without a cutting operation, he is restricted almost entirely to the very probable diagnoses made by an educated bimanual touch in connection with the subjective and other available objective symptoms; and when we reflect upon the high training that may be attained by the skilled finger in detecting the grosser difference between these several conditions, and the fact also that they are all merely different stages and differently situated evidences of the same disease,—inflammation,—it would seem that such diagnoses were amply sufficient for this class of work. If, for instance, the doubt lay between a simple salpingitis or an ovaritis, and the case could be cured by vaginal applications of electricity without resolving the doubt, the patient would surely prefer us to leave the matter uncertain rather than have a dangerous exploratory laparotomy for the satisfaction of curiosity, even though the curiosity be thoroughly scientific.

In their pronounced stages these several conditions are quite amenable to reasonably correct diagnosis by touch, pointing to certain variations in the electric treatment.

In subacute or chronic metrosalpingitis, evidenced by pain between the periods, tenderness in one or both vaginal fornices, and by a more or less clearly defined enlargement of the tube or by mere bogginess in its region, the treatment must at first be altogether vaginal, both constant and induction, though a moderate constant current may be quickly attained. The results in lessened pain and shrinkage of the hypertrophied tissue are soon attested, for the parts are membranous and easily reached by a sufficient density of current, even though indirectly applied. That drainage through the uterus may be promoted, particularly by the negative pole in the vagina, is unquestionable.

Since the last edition of this work appeared I have been able to obtain even better and quicker results from vaginal mercuric cataphoresis in metrosalpingitis, by the technique described at page 132.

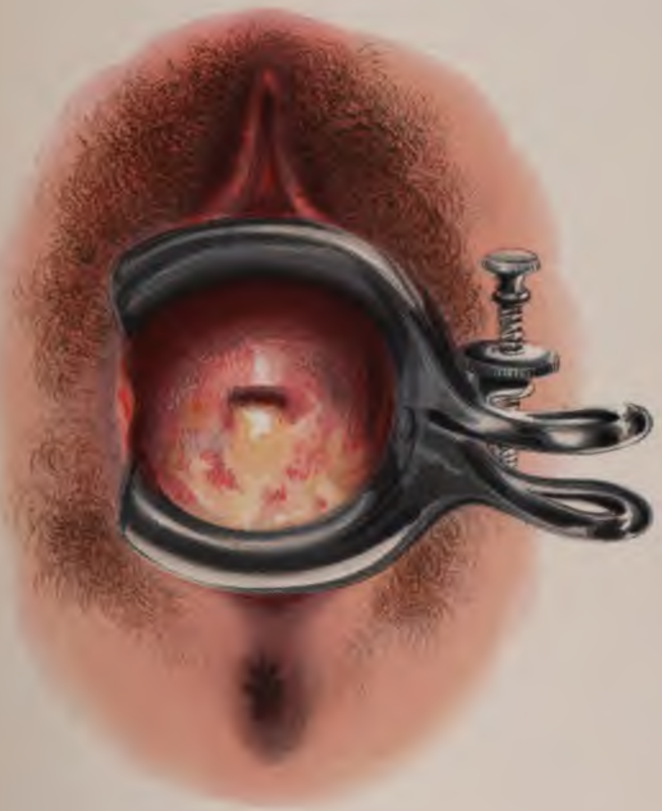
This treatment alone can be relied on to secure a practical cure in a considerable proportion of the cases, but the majority will demonstrate that vaginal applications of electricity alone will be insufficient, for the probable reason that much of the original mischief remains in the uterus. When, therefore, a considerable amelioration of the symptoms has been gained by the vaginal treatment, but the progress thus far made does not continue, the uterus being reasonably movable, though with pain, and manifestly enlarged, we should resort to tentative intra-uterine applications without further delay.

The intra-uterine treatment should, nevertheless, be carefully watched, since acute salpingitis or ovaritis or an encysted purulent inflammation of either organ will be made worse by this form of treatment. Increased pain or a recrudescence of inflammation in a pyogenic cavity will often, indeed, attend the mere passage of a sound; but, as pointed out by Apostoli, an intolerance of intra-uterine constant current applications points so unerringly to encysted pus as to become a means of establishing an exact diagnosis. I am myself convinced that we may trench closely upon this debatable ground with every advantage to the patient if precautions be observed to eliminate all harshness of manipulation from the method. If, for instance, a covered spiral electrode only be used, inserted by touch only without the speculum and without drawing upon the uterus or otherwise disturbing its relations to the surrounding tender parts, we may test the intolerance of the case to electricity itself, which is quite another matter from its tolerance to a more or less brutal handling plus the electricity. The spiral electrode will adapt itself readily and painlessly to any shaped cavity, and, when employed as a positive pole, which is preferable, will not only inaugurate a wholesale change in the activity of tissue-metamorphosis within the affected structures of the uterus, but ultimately promote drainage from the uterine end of the tube. Less pain is produced also if the electrode be only partly inserted during the first applications.

Twenty milliampères is ample for a beginning in these tentative applications, repeated every fourth or fifth day, though the daily vagino-abdominal treatment should be continued as usual. The following cases may be cited as examples in which the uterine seat of the affection was still mainly predominant:—

Illustrative Cases.—Mrs. W. F. D., aged 27, entered the sanatorium from a town in the interior of Pennsylvania with a history of continuous suffering since the birth of an only child eight years before. Instruments had been used at her confinement and she was in bed three months afterward. There was a continuous sensation of weight in the pelvis, a band sensation about the waist, and constant pain in the bladder and ovarian region. Examination

PLATE XVIII.



Purulent Leucorrhea in Metro-Salpingitis of gonorrheal origin.

[illegible]

showed the uterus posteriorly placed, enlarged, and brawny, with a tender mass in the region of the left tube and ovary. She had painful periods and a constant, copious leucorrhea. For two weeks, the patient was placed on vagino-abdominal applications with both currents and general electric stimulation, with but moderate results. I then determined to test the effect of intra-uterine treatment, 30 milliampères, positive, being used with the elastic electrode. Considerable pain resulted from the first application, but before the next day the band sensation had disappeared, and never returned. The intra-uterine treatment was continued twice a week for six weeks, when she returned home practically well. Four years later the permanence of the cure was attested by every evidence of blooming health.

Miss P., aged 24, was suffering from a catarrhal and congestive condition of the uterus and left tube and ovary, traceable to a fall from a hammock sixteen months previously, which had been ineffectually treated by the ordinary methods. The most striking symptoms on admission were weakness in the back, inability to walk far, a sensation described as a burning or itching in the ovarian regions, and a considerable leucorrhea. Examination showed the uterus enlarged and giving exit to a muco-purulent discharge and the left tube very tender. She was placed on positive intra-uterine applications of from 20 to 25 milliampères to the cavity twice a week, and both currents, vagino-abdominal, at frequent intervals for six weeks, followed by occasional intra-uterine applications for three months longer, resulting in relief of all symptoms and a restoration to health which, at this writing, ten years later, remains perfect.

Mrs. W., aged 35, applied at the hospital October 22, 1895, complaining of pain in the back and lower portion of the abdomen and a peculiar sensation in the top of the head, which dated from two miscarriages and a probable specific infection twelve years before. She had been sterile since the gonorrheal attack. Menstruation had been scanty of late. The condition of the cervix and its discharges are shown in Plate XVIII, having been drawn at the time by the artist. The bimanual examination revealed posterior fixation and moderate enlargement of the uterus with indefinable bogginess in the left tubal region. Just before seeing me a colleague in the hospital had given the opinion that a removal of the tubes and ovaries was essential to saving her life. She was placed on negative vagino-abdominal applications of 50 milliampères for three months, during which time there appeared great improvement in the symptoms. The treatment was now changed to cupro-mercuric applications within the uterus of 20 and 30 milliampères once a week for three months. The symptomatic cure was perfect at the end of six months, the patient declaring herself well.

Purulent Salpingitis (Pyosalpinx). — A neglected catarrhal metrosalpingitis, particularly of gonorrheal origin, readily becomes muco-purulent, demanding a more protracted electric treatment before a cure can be obtained by the methods already described. If of long standing, and drainage through the uterine mouth of the tube has been unobstructed, we can readily detect the interstitial enlargement and exaggerated convolutions that have been looked upon as an after-excuse for many unnecessary excisions. Such a condition is as surely curable under positive vaginal applications, assisted by the induction current and by subsequent intra-uterine treatment, as any similar catarrhal affection elsewhere in the body, the intra-uterine treatment being, of course, carefully employed with a view of increasing the drainage. If a true pyosalpinx be suspected to exist on account of the discovery of a cyst in this situation, due to an obstructed uterine end of the tube and accumulation of its muco-purulent contents, the physician is called to make a decision fraught with consequences of intense interest to the patient. *Shall he attempt to cure the patient by restoring the parts to their normal functions, or resort to an operation for their destruction as hopelessly diseased?* This is the burning question of the present day in countless homes, and it is to be feared that the counselors in whose hands the decision has been trustfully placed are at times wanting in a full appreciation of their responsibility in the matter.

The decision that followed as a matter of course at the date of the preceding edition of this work was an immediate operation, involving the removal of the tube and ovary on the affected side. In most cases this first operation was shortly followed by another, in which the remaining tube and ovary were removed. Later, the uterus was removed, and what was then left of the woman after these sexual oblations was advised to "try electricity."

Fortunately, this program, while still adhered to in the "provinces," has been largely replaced in the hands of surgical leaders by attempts at more conservative operations, though the implicit faith in the knife as the only weapon to be employed in the pelvic affections of women remains in evidence.

Elements Governing Decision in Favor of Treatment or Conservative Operation.—Though the author pleads for greater deliberation on the part of medical men in deciding on the proper line of treatment for these cases, including a full recognition of the irreparable change produced in a woman's life by the removal of the appendages (and usually the opposite appendages must either be removed at the primary operation or at a later one, for, of course, these cases of mere inflammatory consequences are never really monolateral), he does not mean to imply that the decision is an easy one to make. A true accumulation of encysted pus in the pelvis must be treated by incision and vaginal drainage, even when subacute. The discrimination between this class and that in which an enlarged tube merely contains muco-pus must be based on the clinical conditions, which show far less acuteness in the latter. The cases of mere mucopurulent accumulation are also more often associated with a chronic discharge from the mouth of the uterus, proceeding at times from the tubes themselves. Finally, the instances of true abscess are almost always traceable to the gonococcus, which introduces additional elements favoring the operation because of the longer time that will probably be required to cause resolution by electric treatment.

But, in the absence of semi-acute pus collections, the physician who favors electric treatment is not compelled to arrive at a final decision between electricity and the knife at once. When in doubt it is his duty to guard the patient's interests by testing the response of the case to vaginal applications, which can do no harm, while they may cure; and if the patient does not improve under a judicious series of such applications he is still in a position to appeal to surgery under improved chances of cure, which is far more than can be said of a reversed order of therapeutic efforts.

The conditions confronting the physician in these patients are well illustrated by the following case reported to the American Electro-Therapeutic Association by the author at its meeting at Buffalo in September, 1901.[1]

The Case of Mrs. D. A Study in Contemporary Gynecology.—The salient points in Mrs. D.'s case run through the whole gamut of modern routine gynecology, but, unfortunately, Mrs. D.'s case is not here reported because of its unusual character. It is rather as an example of everyday experience that I hold up the mirror to this bit of nature and art.

The picture is not a pretty one either, when Mrs. D. is first seen weeping because one of the members of her body had been hastily sacrificed. But this need not be dwelt upon, for how many other women are also weeping that gynecology may teach general surgeons the beautiful art of abdominal surgery?

The medical and surgical history of this case begins, as usual, in painful menstruation. In April, 1893, at the age of 21 years, the cervix was dilated by the young chief of clinic whom she consulted at a college hospital. This forcible dilatation was followed, as frequently happens, by the formation of a tender mass in the region of the *right* ovary. Three months later, while in this condition, she married, her physician advising her to prevent pregnancy for a while, so she states, by the use of douches of cold water.

---

[1] Journal of Advanced Therapeutics, January, 1902, page 31.

Marriage at such a time and in such a condition was necessarily doomed to be accompanied by an imperfect development of the new functions incident to the state, in spite of which it seems that pregnancy ensued and was mistaken by her physician for an aggravation of her inflammatory trouble, and, as the operating days of the chair of gynecology came around regularly, she was persuaded to have the ovary taken out. This was done three months after marriage, the inflamed ovary and tube being removed and a significant curettage of the uterus also performed. From that day the patient states she has been a sick woman.

When first seen in clinic by myself seven years later her condition, which had remained stationary for some years, had recently become worse. The *left* ovary and tube were now in an unhealthy condition, a soft, tender tumor about the size of a duck's egg presenting in this situation, and she had just been told by the surgeon who operated before that another operation was necessary, and the remaining ovary and tube would have to be removed.

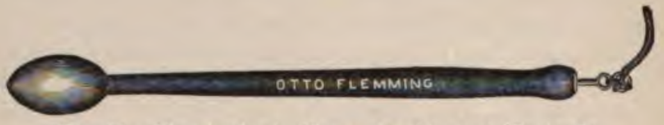


Fig. 38.—The Author's Monopolar Vaginal Electrode.

As the patient was desirous of having children, if possible, I decided to make an effort to cause resolution in the inflamed appendages, believing that the tumor which had caused her advisers to urge her to risk her life again and bring upon herself the consequences of castration was merely a chronically inflamed tube.

The mode of treatment adopted in the effort to produce resolution of this deeply seated morbid process was the well-understood vagino-abdominal application of the constant current, the positive pole being within the vagina. From 50 to 70 milliampères were employed three times a week, followed by the fine-wire induction current, each being allowed to flow four minutes. The only unusual feature of the treatment, and one to which I wish to direct your particular attention, was the use of a bare brass vaginal electrode (Fig. 38) freely amalgamated with mercury. As this pole was positive, the vaginal surface nearest the tubal region received a considerable quantity of ionized mercury and copper by cataphoresis, and, under the repeated applications, much of this highly valuable alterative must have reached the inflamed adnexa. Some irritation of the vaginal surface next the ovary resulted, of course, and after three weeks' treatment the applications had to be intermitted for a time.

At the end of two months the tumor was smaller, a fact which the previous attendant, to whom the patient clandestinely went at intervals, was the first to notice. At the end of six months the tumor could not be found, though some tenderness and contraction of the parts still existed. During the treatment the patient reported periods of leucorrheal flow of a watery character, probably from the emptying tube, but this source could not be verified.

To-day this patient, who had thought seriously of obtaining a divorce from her husband during the seven years since her marriage, is in the enjoyment of a happy married life, clouded only by the continued absence of the stork.

[At the date of publication, more than three years after the above report, the patient continues in good general and local health. The region of the left ovary, which had been the site of the tumor under treatment, presented no evidences of the tumor having been existent except some painless contractions, which were probably in the tissues of the vagina only.]

DISCUSSION.

Dr. Robert Reyburn, of Washington, D. C., said that he had been deeply interested in this paper. For years he had been looked upon by the members of his local society as an old fogy because he was not willing to practice or sanction the present fashionable wholesale removal of tubes and ovaries. He looked upon this practice as a crying shame, and thought the Association should set its face steadfastly against it. The removal of the uterine appendages ruins the woman's life, and is a procedure that should not be resorted to without a most careful and conscientious consideration.

Dr. S. W. Bayliss, of Buffalo, congratulated the author on this very practical paper. Cases like the one forming the text of the paper were met with almost daily in general practice. He, too, believed that the indiscriminate removal of the ovaries was a disgrace to the profession. He thought he had seen ten normal ovaries removed to one abnormal ovary. By the use of the constant current in nonsuppurative cases the painful pelvic conditions could be almost always relieved, even though it might be necessary to extend the treatment over a period of three or four months. With the high-tension coil the pain could be relieved immediately—indeed, almost instantly upon adjusting the vibrator so as to secure rapid and smooth vibrations.

Dr. O. S. Phelps said that he coincided most thoroughly in the conservative view that had been expressed by the preceding speakers. He recalled an instance in which he had assisted another surgeon in operating upon a case in which one ovary and tube had been converted into a pus sac and the other ovary enlarged and inflamed. As a portion of the latter ovary was still normal he urged the operator to save it, and this had been done, with the result that he had the satisfaction of having the woman subsequently menstruate regularly. He seldom approached an operation that he did not prepare his patient for the operation by constant current treatment. His object was to get rid of as much exudate as possible, as this greatly simplified the operation.

In many cases in which inflamed ovaries were bound down by adhesions he had had the great satisfaction of relieving the ovary from the pressure of the exudate, and making an operation unnecessary. An illustrative case was cited. The patient was a woman with a supposed fibroid tumor reaching to the umbilicus. She had had hemorrhages for which she had been treated medicinally by the family physician. Dr. Phelps had succeeded in checking the hemorrhage by zinc electrolysis, using at the first application 125 milliampères, and afterward usually from 25 to 30 milliampères, anodal, for from ten to fifteen minutes. After about two months' treatment the tumor had become perceptibly smaller, it being about one-third of its original bulk. He had then been able to map out four small fibroids. The woman at this time did not desire operation if electric treatment could complete the cure. He had accordingly continued the treatment, and she had paid him altogether one thousand dollars, and had been made happy by thus escaping operation. This was truly a most instructive case, but electro-therapeutists should be careful not to carry this idea of conservative surgery too far. If there be a possible chance to avoid operation the patient should be given the benefit of the doubt.

Dr. R. J. Nunn, of Savannah, referred to the case of a woman, the mother of three children, who had come to Savannah about three years ago. She had been treated for ovarian pains in various cities in which she had been living. Some minor operations had been performed, and she had been advised by her physician to go to a hospital and have some operation performed, the exact nature of which the patient did not know. She had finally fallen into his hands, and he had used upon her the combined constant and induction currents. For several months she had been relieved absolutely of pain. About that time Dr. Nunn said he had been compelled to give up practice because of ill health, and the woman becoming ill again had been persuaded to submit to operation at a hospital. She had died as a result of it. Another case had recently come under his observation, which was still more melancholy an example. The patient was a woman of 28, who was subject to certain seizures which, from the description, he took to be hysteric convulsions. The uterus and adnexa had been removed by some practitioner, but the woman was just as ill afterward as before. The speaker said that when he had examined her he had found intense tenderness and soreness of the whole spinal column, extending up even into the occipital bone and mastoid processes. Electricity had not been tried, and a thorough examination of this woman had never been made before subjecting her to this mutilating operation. This seemed to him disgraceful.

The author, in closing the discussion, said that his object in reporting the case had been twofold: to point a moral, and to call attention to a new application of mercuric cataphoresis. The case was not an extreme one, and had been presented as merely one illustration of the testimony we should bear against a dreadful practice now prevailing.

The treatment described would be found more effective than the application of the constant current to the vagina, yet shared with it the advantage of avoiding all risk attending intra-uterine applications. It is necessarily tentative, of course. The method was easy and inexpensive. He had used in this case an old-fashioned brass olive electrode of large size heavily coated with mercury.

Mercuric cataphoresis as a re-enforcement of the constant current anode in the vagina, as described in the paper quoted above, is unquestionably a most valuable procedure. That the ionized mercury must be diffused in considerable quantity during a two or three months' treatment is made evident by a deterrent action on menstruation that appears in most of the cases subjected to it for a sufficient time, the menstrual function having been suppressed for one or two months in each of the following cases:—

Miss E., of West Philadelphia, aged 35, with a history of leucorrhea and menorrhalgia previous and subsequent to the removal of the left ovary, two years before I first saw her, came under observation in September, 1901, saying she had as much menstrual pain, intermenstrual pain, backache, and local tenderness in the left tubal region as before the removal of the ovary and tube. The leucorrhea was especially abundant.

She was placed on triweekly brass-mercuric applications to the tender spot in the vagina, each application of the mercury being followed by several minutes fine-wire induction currents. The second period after commencing treatment was missed, a profuse leucorrhea continuing. The treatment was discontinued for a month, when she had a painful period as before. The mercuric cataphoresis was now resumed and continued for another month, by which time all symptoms were relieved.

This patient had no return of the symptoms, and has since married.

Mrs. N., a nullipara, aged 31, entered the sanatorium from a town in Kentucky in October, 1901. Six years before, shortly after her marriage, she had an attack of pelvic peritonitis that left the pelvic organs matted together, a condition that still existed, the boardlike roof of the pelvis shown in Fig. 39 being particularly evident to the bimanual examination. Large tumefactions existed in both ovarian regions, a constant pain was complained of in the left ovarian region, and there was a copious purulent discharge from the uterus with unpleasant odor.

During the treatment of this case several periods were passed without appearance of menstruation, though symptomatic improvement was marked. For nearly three months the mercuric applications were made daily, every effort being made to save her from operation. The final result was a symptomatic cure, examination showing also that the organs were more mobile and tumefaction lessened. The improvement still continued when the patient was last heard from, one year after her return home.

Mrs. P., a nullipara, aged 38, of Ocean Grove, N. J., applied for treatment in November, 1902. An old uterine affection had been aggravated by unusual effort during the previous summer in nursing her mother through a fatal illness. She had recently been advised to have an operation performed for the removal of the right tube and ovary.

On examination the uterus was found enlarged in the corpus only. In the region of the right tube there was a sausage-shaped mass that could be easily made out as an enlarged tube owing to the absence of adhesions.

She was placed under vaginal mercuric cataphoresis, and in two and one-half months' time both a symptomatic and anatomic cure was effected. A year later she sent word that her health remained excellent.

Hematosalpinx.—This condition is not easily distinguished from pyosalpinx except by its recent appearance. In a thoroughly conducted transillumination of the pelvis a dark cloud will be found in

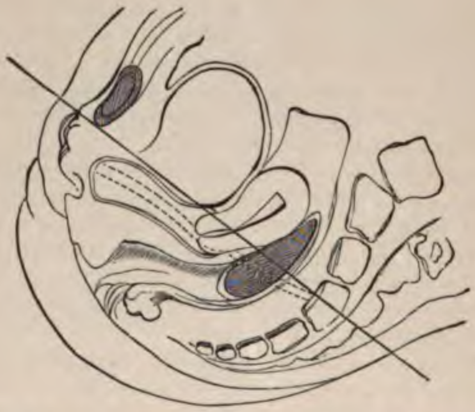


Fig. 39.—Line of Rigidity in Pelvic Peritonitis. *(Thomas and Mundé.)*

the situation of the tubes in both affections. Hematosalpinx is now thought to be an arrested tubal pregnancy in some cases. Being but an effusion of blood or of blood and mucus, the proper treatment is a promotion of its absorption by negative vaginal applications of the constant current, the intravaginal electrode being pressed against the tumor as in the treatment of ectopic gestation. Several weeks' daily treatment with current-strengths of 50 milliampères will usually be found sufficient to cause material shrinkage and final disappearance of the tumefaction. An abdominal section for an accumulation of material so easily absorbed as this is totally unjustifiable.

Hydrosalpinx.—This condition may be approximately distinguished from pyo- and hemato- salpinx by the absence of tenderness and adhesions and by its long-standing character. Under transillumination no cloudiness is observable in the situation of the tumor. The same measures are appropriate in its treatment as have been advised for pyosalpinx.

Pelvic Peritonitis.—This affection is usually consecutive to catarrhal disease of the uterus and tubes. The therapeutic management of an acute attack by the ordinary antiphlogistic measures, such as ice, iodine, etc., to the abdominal aspect of the swelling may be greatly assisted by the use of Apostoli's suggestion of bipolar, fine wire induction applications within the vagina, as in the acute cases of salpingitis and ovaritis. No pain whatever should be produced either in inserting the warmed electrode or by the current, the latter being turned on very gradually and used for fifteen minutes daily, if relief of pain is gained. The cessation of pain by this means can only indicate more or less arrest of the congestive process attending the advance of the inflammation.

In the treatment of the later stages of the acute process the bipolar induction current is also most useful, to which should be added vaginal mercuric cataphoresis in the more chronic cases. The rapidity with which the exudation forming the boardlike vault of the vagina, encountered by the finger in a plane represented by the dotted line in Fig. 39, may be made to disappear under this treatment is often astonishing, even when the agglutination of the pelvic organs is of long standing. The case related on page 135, as well as the following case, are excellent examples:—

Illustrative Case.—A married lady, 37 years old, was referred to me by Dr. J. A. Draper, of Wilmington, Del. She had had a miscarriage seven years before and various attacks of probably specific vaginitis since, culminating in metrosalpingitis and pelvic peritonitis. Under the pain of the latter condition she was fast developing an opium habit. Examination revealed an enlarged uterus set in a hardened pelvic vault just as if plaster of Paris had been poured over it, as described by Thomas and Mundé. She was admitted to the sanatorium on March 25, 1891, and placed on negative vagino-abdominal applications of 75 milliampères, occasionally changing to constant current alternatives in the same situation, together with the general rest cure treatment. By May 5th she was symptomatically well, and my notes speak of great loosening of the uterus, though slight tenderness persisted to the left of the uterus. Several office applications were made during the following month, and on October 2d it is noted that the uterus is quite small and movable, and that no symptoms remain. This lady was seen five years later in the best of health, which she attributed to the treatment received.

CHAPTER XI.

CHRONIC INFLAMMATORY AFFECTIONS OF THE OVARIES.

Chronic Ovaritis.—The unexampled opportunities for the study of inflammatory affections of the ovaries after the operative removal of these organs, recently enjoyed by the younger school of gynecic surgeons, might have yielded greater good to pathologic science than to some of the patients operated upon had the bucketfuls of specimens brought to the societies been thoroughly studied. As it is, the most important lesson taught by this misdirected energy, aside from its evidence of the cyclonic character of variations in professional opinion, is that ovarian and tubal affections are not easily differentiated from each other prior to operation, and that it is equally difficult to distinguish a curable from an incurable disease of these organs by a simple examination. The great majority of ovaries and tubes thus hastily condemned to extirpation are found after removal to be the seat of simple inflammation, and their unfortunate destruction is a heavy tax to pay for a relatively small number of cases incurably diseased thus discovered.

A means of practically averting this causeless unsexing of women has been indicated by Apostoli, the careful application of which should do much to confine castrational operations within their legitimate limits of the removal of useless organs. This consists in diagnostic test treatments, which, by aggravating the symptoms, make out a clear diagnosis of a condition demanding operation, or else, by ameliorating the symptoms, indicate infallibly the presence of a curable lesion.

This diagnostic test comprises two procedures: a vaginal bipolar fine wire induction application, and an intra-uterine constant current application. If the former relieves the pain at once, or after several sittings, the probability is that the condition is neuralgic or congestive and scarcely inflammatory even. If an intra-uterine application of from 35 to 50 milliampères, made with a covered,[1] elastic electrode, aggravates the pain greatly and persistently, the possibilities are strongly in favor of a grave inflammation of the adnexa that indicates operative procedures. There is, of course, some discomfort under the second test even in curable cases, and this is more pronounced if the electrode be rigid and inserted with harshness; but the modification of Apostoli's method which I employ, consisting in the use of an elastic electrode, constitutes a most delicate test, as the pain reaction of such an application is at a minimum in cases amenable to electricity.

---

[1] The use of a covered elastic electrode makes this test more delicate than contemplated by Apostoli, eliminating the mechanical harshness of a stiff sound.

In my own practice such a test is rarely applied in this way, since I am convinced that many inflammations of the tubes and ovaries are capable of relief by electricity applied by the vagino-abdominal method that would be aggravated by intra-uterine applications. It is only, therefore, when a vagino-abdominal or bipolar induction application fails to give relief, and a simple vagino-abdominal constant current application aggravates the pain, that a conclusion is arrived at that the condition is one that is impossible to cure in this way; for an intolerance of such treatment surely indicates too advanced a process, with suppurative consequences or other incurable local faults.

As already remarked, the differential diagnosis between chronic catarrhal salpingitis and simple chronic ovaritis is difficult of establishment with absolute certainty, either from the subjective symptoms or by the bimanual examination, but the electric treatment of the minor stage of either condition is practically the same. The treatment, in other words, is directed to the inflammation itself, the current promoting absorption of the interstitial effusion as well as of edematous and serous collections whether situated in the tubes or ovaries. Such a method is necessarily interpolar and but slowly effective in some cases, but the importance of the results that can generally be secured is very great and well worth the time and labor expended.

The applications should be made daily or thrice weekly with both currents, the positive pole of a 30 to 60 milliampère current being employed for five minutes, followed by a medium or fine wire induction current of the same duration, without removing the electrode. The latter should be a brass or zinc vaginal instrument covered with absorbent cotton, wet and soaped, and gently pressed against the ovary through the vagina. After turning the induction current off, the electrode may be gently shifted to the other side, if both ovaries be affected, and this current again turned on, though it is wisest to reserve the constant current in this situation till the next *séance,* alternating the sides for its application. Each application should be followed by repose in bed when this is practicable.

Under this treatment the pain and tenderness lessen and adherent ovaries become looser through absorption of the bands of exudate, the symptomatic improvement proceeding with equal pace with the trophic and vascular restoration. From six weeks to six months will usually be required to attain such results.

Since the previous edition of this book appeared I have been able to shorten this treatment in some cases, and include instances of more extensive inflammation in its field of usefulness, by changing the constant current positive application into an application of mercuric cataphoresis, as described in the preceding chapter. To do this the vaginal electrode, which should have a bulb about the size of a pigeon's egg, is amalgamated with mercury and used uncovered.

A more serious condition is present if the ovaries become prolapsed by reason of increased weight and the dragging effect of adhesions from attacks of circumscribed peritonitis. In this state the wisdom of sacrificing the organs by removal becomes a question of importance, as their dislocated position renders them more subject to relapses and aggravations of the inflammation. It should be remembered, however, that the suffering is entirely due to the ovaritis and other inflammatory conditions preceding and accompanying it, often to a still existing endometritis or metritis, and that if we can restore the parts to a healthy condition in this respect a symptomatic cure may be attained, even though it be impossible to restore the organs to their proper position. The fact that the dislocated position of the organs renders pregnancy unlikely because of the lack of coaptation of the fimbriated end of the tube to the ovary is no real argument in favor of the removal, as one can never be sure that the tube is not equally displaced and thus capable of performing its functions if rendered free to move. An incurable tenderness or painfulness is the only practical or reasonable indication for castration. That a permanent symptomatic cure of ovaritis complicated by prolapse of the organ may be attained is attested by the following cases, which have been under observation for some time since the cessation of treatment:—

Illustrative Cases.—A young lady, aged 21, was sent to me by Dr. John Chambers, of Kingston, N. Y., May 20, 1892, with the following history: Her mother died of phthisis and her father and a brother of Bright's disease. She herself had always been delicate, particularly since puberty, which appeared late with irregular menstruation, quickly developing intense menorrhalgia. At 18 she was sent to Dr. T. Gaillard Thomas, who inserted a pessary, which relieved her for a time, but subsequently gave rise to much suffering. Returning to Dr. Thomas in 1891, she was placed under treatment at the Woman's Hospital, where oöphorectomy was advised after a period of treatment.

Her general condition on admission to the sanatorium was poor, evidencing malassimilation and some nervous prostration. The principal symptoms of discomfort were, however, directly traceable to the pelvic condition. The sitting posture, and particularly the use of a rocking chair, aggravated the discomfort and pain in the pelvis, which was constant between periods and extreme during the flow. Leucorrhea had been quite bad since the pessary was inserted. The menstrual periods were profuse, with worst pain on first and third days. Examination showed tender and prolapsed ovaries, the left being enlarged and lowest, with enlarged and prolapsed uterus, the latter being near the pelvic outlet and exuding a copious leucorrhea. The uterine cavity measured three and one-fourth inches. Much pain was developed by the examination.

She was placed on positive vagino-abdominal applications of 50 milliampères, followed by the secondary induction current in the same situation and general electric stimulation; the applications were made daily, followed by rest. Great amelioration of the tenderness of the left ovary followed. At the end of the second week a mild intra-uterine positive application with a covered elastic electrode was made, and repeated once in seven days during the remainder of the treatment, which was continued for two months. On discharge her condition was so satisfactory that a symptomatic cure was noted.

In a letter dated February 3, 1896, more than three years after the end of the treatment, this lady reports herself in the best of health, which she attributes entirely to the methods employed. I have unfortunately no notes of the size of the uterus or position of the ovaries subsequent to the treatment, but regard this defect in the record as of less importance than accurate statements of the ultimate result in the restoration of conscious health.

A more difficult case was that of a married lady of 27, referred to me by Dr. Potter, of Germantown, October 25, 1893. This lady was the picture of robust health in spite of an hypertrophied uterus and deeply prolapsed ovaries, the latter being enlarged, tender, and giving her much discomfort when walking or riding. The trouble dated back to a prolonged labor followed by laceration of the cervix, for which a repair operation had been done by a distinguished surgeon. There was a copious muco-purulent leucorrhea. In spite of the excellent union of the cervix obtained in the plastic operation the uterine body remained hyperplastic, the seat of an unpleasant discharge, and had a cavity measuring more than three inches in depth. The menstruation was irregular, appearing in periods of thirty-one and forty-one days.

Vagino-abdominal treatment seemed to be of little service in this case, probably because the ovaries were not the principal seat of the trouble, though out of place, and it was necessary to attack the uterine trouble by intra-uterine constant current applications. Owing to the great increase of tenderness evoked by these applications, which were negative and applied by the covered elastic electrode, not more than 35 milliampères were used, and generally less, twice a week, followed by the contracting, primary induction current to the point of tolerance, then by a bipolar secondary. As a result, the leucorrheal discharge was cured, but when the patient ceased attendance the symptomatic cure and reduction of bulk were still imperfect.

It is possible that, had this patient realized the importance of long-continued and regular treatment, as good results would have been attained as in the following case:—

Mrs. J. F., aged 31, applied for treatment at the gynecologic clinic May 7, 1896, with the following history: Her only child was 11 years old. Eight years ago she had miscarried and had been an invalid ever since, having had vaginitis of probably gonorrheal origin about the time of the miscarriage. She had received the usual treatment, including pessaries, which gave so much discomfort as to compel their discontinuance, and the advice that her ovaries should be removed was given at several hospitals. There was but slight leucorrhea at this time.

Examination showed an enlarged and flabby uterus, somewhat retroposed, with tender tubal regions and distinctly prolapsed and enlarged ovaries.

She was placed on vaginal positive applications of about 50 milliampères three times a week. This was continued with great regularity for three months, during which time distinct improvement was noted in both the subjective and objective symptoms. On August 11th the tenderness had so far abated that it was considered wise to begin intra-uterine applications of 40 milliampères, positive, followed by the fine wire secondary. This was well borne, and was continued at weekly intervals for three months. In the latter part of January, 1897, the patient had the pleasure of realizing that she was not only restored to complete subjective health, but was also pregnant for the first time in nine years. Her health continued excellent under this trying ordeal, and in October, 1897, she was delivered after a remarkably short and painless confinement.

Ovarian Congestion.—Aside from these marked instances of physical deviations from the normal size and position of the ovaries, we have also a numerous class of cases among young women who complain of pain and tenderness in one or both ovarian regions so little accompanied by other evidences of physical disease, such as persistent leucorrhea, as to render a physical examination both unnecessary and unwise. These cases, well described by Skene,[1] are but derangements of function unaccompanied by structural changes of the organs, though generally accompanied by congestion or hyperemia. It is usually thought that conditions of life favoring excitation of the sexual function without complete functionation (as in morbidly introspective girls, unhappily married and childless women, and widows) are the principal predisposing conditions, but I have observed the affection frequently where these conditions are replaced by causative factors depending on nutritive disturbances of all the vegetative functions of life, including vasomotor irregularity, constipation, lithemia, neurasthenia, and, of course, hysteria. There can be no question, though, of the tendency of this condition, left to itself, to develop into genuine chronic ovaritis; hence it is important to direct attention to the local condition as well as the general nervous disorder.

---

[1] "Medical Gynecology," by Alexander J. C. Skene, page 220. D. Appleton & Co.

Together with a removal of the cause or causes and regulation of the alimentary functions, there is no form of treatment for persistent cases of ovarian hyperemia equal to external abdomino-dorsal applications of both currents accompanied by a judicious course of the rest treatment, inclusive of general electric stimulation and massage; provided this be carried out in a properly regulated institution and away from the accustomed scenes of home and overzealous friends. The rest cure at home is usually thoroughly impracticable in its essential features, and even under the most favorable conditions for its employment it must be associated with the local external treatment described in order that permanent results may be attained. Skill in managing such cases is only attained by physicians who understand that a large proportion of the work in the diseases of women demands a combination of the skill of the neurologist with that of the gynecologist.

Illustrative Case.—Mrs. M., aged 31, of Spottswood, Va., was sent by Dr. W. H. Thomas, of Steel's Tavern, November 29, 1899. She was of a neuropathic family, and had suffered from a pelvic inflammation seven years before, and for a year was afflicted with pain in the spinal and occipital regions, especially manifest in the region of the coccyx. Sitting for any length of time aggravated the symptoms, and walking prostrated her. The digestive functions were good, though she weighed but 82 pounds.

Examination showed the left ovary tender and enlarged, the uterus retroposed, anteflexed, and partly fixed, and exuding a copious white discharge. Examination of the spine showed remarkable hyperesthesia throughout its whole extent.

She was admitted to the sanatorium and placed under the treatment described, which included absolute rest for two weeks only. For the remainder of her stay the rest was replaced by static electricity and exercise. At the end of two months she was discharged, apparently cured, her weight having increased to 107 pounds.

After spending ten months at her home in a greatly improved condition it was thought wise for her to return for additional intra-uterine treatment, which required an additional four weeks. On final discharge her condition was excellent, and her weight had increased to 118 pounds.

This patient had, of course, been advised that the ovaries be removed; with the accompanying nervous conditions the result of such a course can well be imagined.

Postoperative Traumas and Neuroses.—It is inevitable that the physician will be appealed to to alleviate the sufferings of those patients who have failed to be relieved by removal of the ovaries, and, at times, of the uterus also. Whether the sufferings of these unhappy beings be due to neuroses left untouched, or even aggravated, by the profound mental and physical results of castration, or caused by unhealthy stumps, or from still existing chronic metritis after the appendages have been removed, the best chance for final relief is usually from electric treatment. The author has seen many such, with varying results from treatment, but possibly the following case is most instructive:—

Mrs. ——, aged 41, the wife of a Chestnut Street merchant, had suffered from pelvic disorder of some kind after the birth of her only child, twelve years before. Treatment by tampons and pessaries being ineffective, she was finally persuaded to have both appendages removed four years before first seeing the writer, in March, 1901.

The patient stated that shortly after this operation the present symptoms began, somewhat suddenly, since when she has been a real invalid, her sufferings before the operation being as nothing compared with those encountered since. These symptoms were in the nature of an insupportable aching sensation, centering in the region of the uterus, whenever she was in the erect posture. One year after the castration a second operation was performed for the relief of this symptom, taking the form of a removal of the uterus by the vaginal route. This gave her no relief whatever, and when first seen by the writer she had been compelled to lie on her back day and night, with the exception of an occasional half-hour, for three years.

The patient was in apparently robust health otherwise, except for a natural aggravation of her emotional nature. There was no hysteria. Examination failed to reveal a prolapse of the vagina, but did show a tender mass just above the apical cicatrix, which seemed to be about the size of a marble. The absence of abscess formation made the possibility of an infected ligature unlikely.

She was placed on the vaginal mercuric method triweekly, with which was associated some static treatment. While awaiting her turn in the reception room she was compelled always to lie down, though able to come to the office in a conveyance.

The treatment was pursued faithfully for more than a year, or until June, 1903, when she was sent to the coast of Maine for the summer. On her return the improvement was sufficient to permit of further intermission in the treatment. During the following winter she was able to engage in her social duties to a considerable extent, though subject at times to such unpleasant relapses that at one time the writer made arrangements with a surgical colleague to have the abdomen opened for exploratory purposes and removal of the still tender spot. These relapses finally grew less, and the spot less tender, until a practical cure resulted, without further treatment of any kind.

CHAPTER XII.

FIBROID TUMORS.

PROBABLY the best definition of a fibroid tumor of the uterus may be adapted from Cohnheim as *a localized increase of tissue similar in structure to the uterine body, but the product of embryonic cells of congenital origin, produced independently of microbic causes, and of a benign character*. While spoken of generally in English-speaking countries as fibroids or myofibromata, they are strictly termed fibromas if the fibrous tissue natural to the uterine wall predominates, or myomas if the muscular tissue predominates.

They arise within the wall of the corpus usually, rarely in that of the cervix, and push aside the normal tissues in their growth, being thus encapsulated, and do not blend with or invade the normal tissue as is the case with malignant tumors.

Origin.—The most reasonable theory of the origin of fibroid tumors is that of Cohnheim,[1] who advanced the hypothesis that they arise from a matrix of embryonic cells of fetal origin which have failed to develop into mature cells like those surrounding them. These cells are supposed to have remained dormant during the growth of the general body structures on account of the physiologic resistance presented by more highly developed tissues surrounding them. Should this physiologic resistance of the environment remain in a normal condition, the remnant of fetal structures continues dormant as a "fetal rest." Should, on the other hand, this physiologic resistance of the surrounding tissues be lessened by disease, such as a microbic invasion and inflammation, a traumatism, or by the special activities of puberty, the embryonic matrix becomes active and proliferates in accord with its crude endowments, absorbing nourishment from the surrounding tissues and vessels. The tumor-matrix is, therefore, prenatal, and may remain permanently dormant unless afforded an opportunity for growth by influences that depress the normal inhibiting power of the vital forces.

---

[1] According to Mr. W. R. Williams, in a paper read before the British Medical Association at Carlisle, the theory of the "fetal rest" origin of tumors was first conceived by Professor Durante, of Rome, Italy, in 1874.

Effects of Electric Treatment Corroborate Cohnheim's Theory.—This theory of tumor-formation bears many evidences of its truth though essentially hypothetical, not the least of which is the excellent explanation it affords of the phenomena accompanying the electric treatment of these neoplasms. It will be seen that the two elements essential to the existence of a tumor are a matrix of embryonic cells and a released inhibition to their proliferation. That such a proliferating matrix may be checked by a trophic blow transmitted to the matrix by a heavy current, or by an electric stimulation of the physiologic resistance of the surrounding tissues, is quite evident; and that

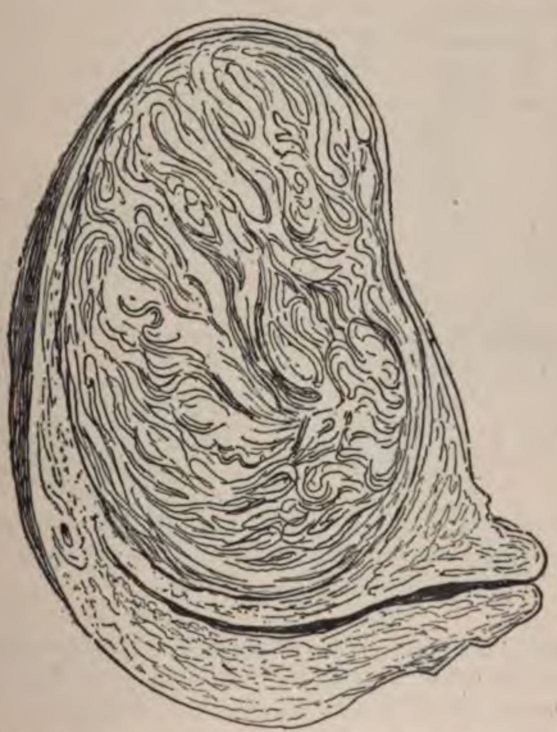


Fig. 40.—Intramural Fibroid Tumor. (Drawn from Specimen in the Mütter Museum of the College of Physicians of Philadelphia.)

these are the two modes in which electricity acts upon fibroids, rather than by destructive electrolysis, I have long felt assured.

Clinical Varieties.—A fibroid tumor grows from one or more congenital matrices within the tissue of the uterine wall, pressing the normal uterine stroma before it, and tends to develop most in the direction of least resistance. If this center of growth appears about the middle of the uterine wall an equable enlargement of that portion of the uterus results, as in Fig. 40, the unaffected tissues being displaced in all directions, giving rise to the most common clinical variety, known as an intramural tumor. If the center of growth be nearer the mucous membrane than the peritoneal covering it will in time project more or less into the uterine cavity, forming the submucous variety (Figs. 41 and 42), which may, by still farther projection into the cavity, become pedunculated, forming a fibroid polyp (Fig. 43). If, on the other hand, the center of growth be nearer the peritoneal surface, it will again follow the lines of least resistance, and by projecting into the peritoneal cavity become subperitoneal (Fig. 44), or, by a complete emergence, may become pedunculated (Fig. 45).

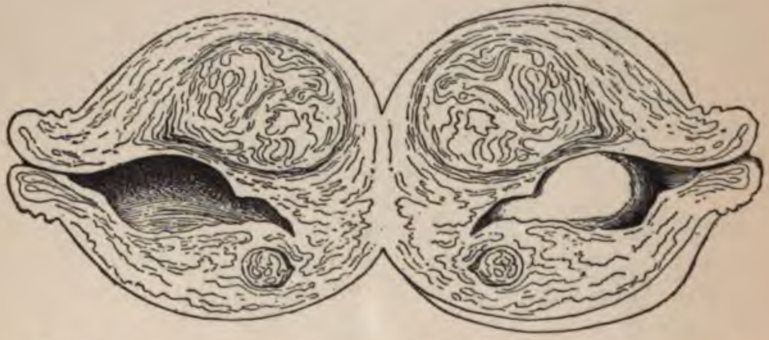


Fig. 41.—Submucous and Intramural Fibroid Tumors. (Drawn from Specimen in the Mütter Museum of the College of Physicians of Philadelphia.)

Whether a given matrix of growth will develop into either of these varieties depends, therefore, on its original situation in the uterine parenchyma and the direction of least resistance to its physical encroachment. In growths of more than one matrix each variety may be found co-existing, particularly the intramural and subperitoneal, and an intramural tumor may later take on the characteristics of either a submucous or subperitoneal form as it emerges from either surface.

Certain tumors possess so many matrices of development that the whole substance of the uterus is permeated with the resulting growth, which resembles a symmetrically enlarged uterus. This variety is known as the interstitial fibroid (Fig. 42).

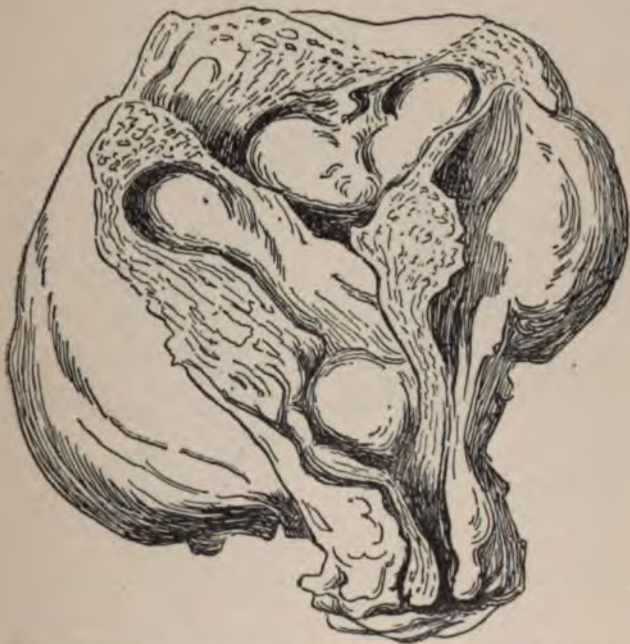


Fig. 42.—Multinodular Interstitial Fibroid with Submucous Projections. (Drawn from Specimen in the Mütter Museum of the College of Physicians of Philadelphia.)

These neoplasms, particularly when the fibrous tissue predominates, are of very slow growth, sometimes existing ten or fifteen years before becoming abdominal in situation and large enough to be felt above the pubic bones. At times, indeed, nonhemorrhagic varieties are not discovered by either the patient or her physician until they have attained a number of years' growth and the size of a cocoanut or larger, so slight had been the symptoms of their presence. In other instances the initial nodules, no larger than a pea, give rise to intense suffering at a time in their history when they remain undiscovered, the patient going through a fruitless succession of attempts to be cured of suspected ovarian disease, displacements, etc.

It is in this initial stage that these tumors are most generally and readily amenable to electric treatment, not only because their small size renders equal currents and periods of treatment more effective than in larger ones, but because all such tumors are, in this stage, capable of arrest and absorption, while some of them later, by excessive growth, extrusion beyond reach into the abdominal cavity, or degeneration, will become unfit for it.

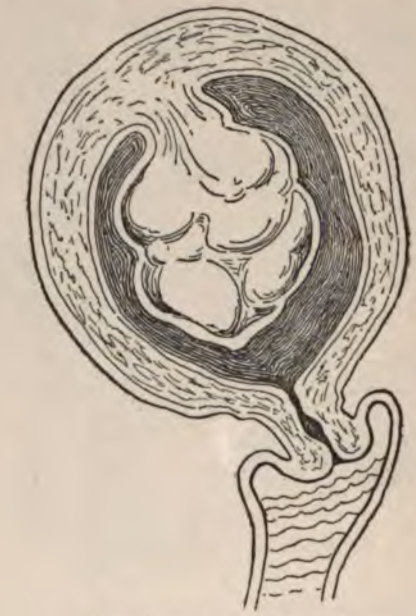


Fig. 43.—Fibroid Polypus.

Any uterus suspected of being the seat of this neoplasm should be promptly placed under the Apostoli treatment therefore, the treatment being continued until the diagnosis is either cleared up negatively by the restoration of the uterus to its normal dimensions and the disappearance of symptoms with the cure of the simple hyperplasia that existed, or until a nodule can be made out by the shrinkage of the uterine wall surrounding it. In the latter case we are enabled to make a diagnosis of an incipient fibroid with certainty, and should continue the applications for a longer period to bring about a still farther retrogression, or a possible disappearance, of the tumor itself.

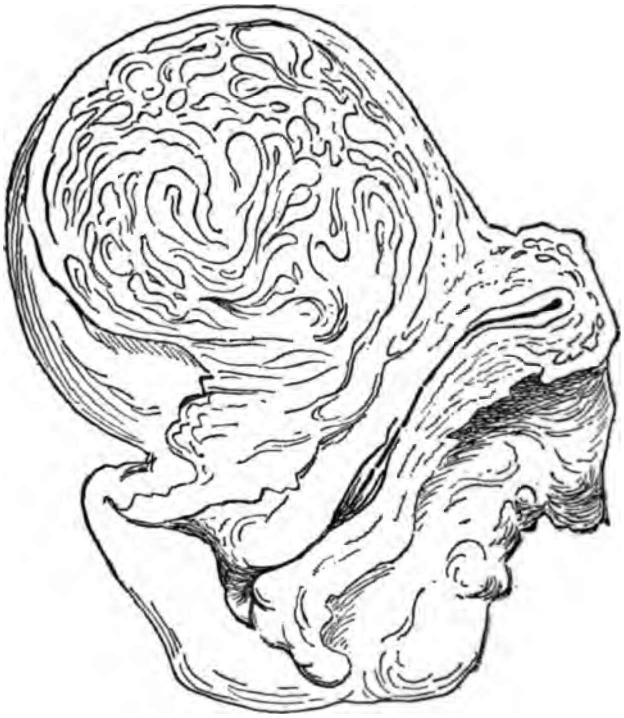


Fig. 44.—Subperitoneal Fibroid with Sessile Attachment to Posterior Wall of Uterus. (From Specimen in the Mütter Museum of the College of Physicians of Philadelphia.)

It is fortunate that the applications essential to the cure of simple uterine hypertrophy and of interstitial or intramural fibroids of small size are identical, being intra-uterine applications of the negative pole of from 25 to 150 milliampères in nonhemorrhagic cases, or of mercurial cataphoresis of the same strength and locality in hemorrhagic cases. Such an early recognition and prompt remedy of a tedious and troublesome affection, leaving the patient in the complete possession of both her health and her organs, merit the highest plaudits conferable on scientific skill; but unfortunately the human mind is so constituted as to feel far greater interest in the comparatively gross act of removing a palpably large tumor with the knife, together with sundry organs of precious worth to a normal woman.

Natural Prognosis of Fibroid Tumors Without Treatment.—Fibroid tumors are essentially and strictly benign and have no connection whatever with malignant growths, though in very rare instances they have been known to become the seat of malignant degeneration late in their history. Such a termination is, however, so rare as to be a curiosity. The life of the patient is never threatened, but by some form of degeneration, and it has only recently been appreciated by the profession that the deaths after efforts at removal by the knife represent almost the entire mortality of these growths.

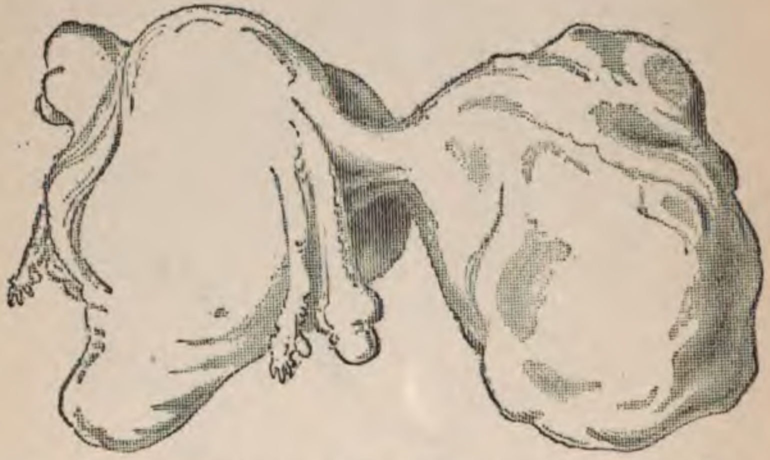


Fig. 45.—Pedunculated Subperitoneal Fibroid. (From Specimen in the Mütter Museum of the College of Physicians of Philadelphia.)

Apostoli's Discovery.—The world is indebted to the late Georges Apostoli, of Paris, France, for the practical discovery and demonstration that fibroid growths are amenable to electricity, though Cutter, of this country, had used this remedy in fibroids in a crude manner before him and had called attention to its value. Apostoli's modest claim, first put forward in the early 80's, that electricity will cause a symptomatic cure—arrest of growth and anatomic regression—of a large proportion of such cases without danger, has been verified in all portions of the civilized world, many operators, including the author, going even farther than he originally claimed in reporting actual anatomic disappearance of some growths under their care. The inevitable result of such an announcement has been intensified by the fact that it was made at a time when the early triumphs of antisepsis were inviting surgeons to added daring in abdominal operations, and hence a most powerful and influential opposition was aroused. Some surgeons, it is true, took it up without sufficient preliminary training to make a success of it, and others after adopting it have frankly confessed that it hurt their more remunerative surgical reputations; but it remains a fact that no single person who investigated the subject in a truly scientific spirit has seen fit to reject it as a most valuable addition to the resources of the curative art. The history of this subject has reached such enormous dimensions that

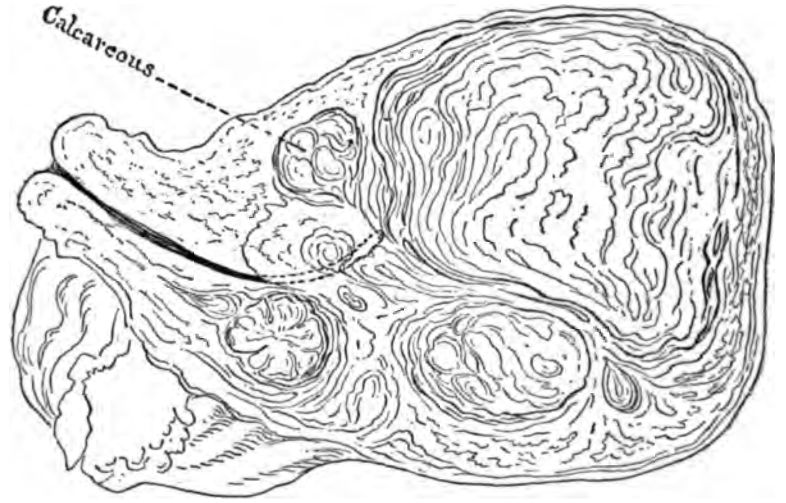


Fig. 46.—Multinuclear Interstitial Fibroid with One Nodule Affected by Calcareous Degeneration. (From Specimen in the Mütter Museum of the College of Physicians of Philadelphia.)

even a cursory review would be out of place in pages devoted to the practical side of the work, and I may merely add that we are indebted most particularly to the late Dr. Thomas Keith, of London, formerly of Edinburgh, the first and most eminent surgeon to successfully remove large numbers of fibroid tumors with the knife, for a most effective plea in favor of a trial of the Apostoli treatment before the performance of any more bloody operations with the knife, and who, in collaboration with Dr. Skene Keith, published a work[1] containing the details of 106 cases so treated. In the introduction to this work these justly eminent surgeons say:—

> For long we had doubts as to the permanency of the treatment in the early cases. The later work has been much more satisfactory. But now more than two years have passed since all operations were given up for this treatment; and our first patient writes—and no one could have had more hemorrhage—that she has been perfectly well all summer, climbing hills and rowing in a boat. Another of the early and doubtful ones, who could never bear a large dose of electricity, tells us: "I am now in excellent health, without an ache or pain of any kind, and my periods are just a show, and nothing more, and give me no discomfort whatever. I hope you have been as successful with all your other patients as you have been with me. But it cannot be otherwise, for I am sure that no one could have been worse than I was with that awful hemorrhage." This patient's importunity had almost driven me into doing hysterectomy for her.
>
> At first we fell into the natural mistake of trying electricity on every case that presented any symptoms,—in some when the tumors were almost certainly sarcomatous, and even in one who was in the last stages of old cardiac disease. We know now that the cases best treated are those who are suffering much from hemorrhage,—the more, the better,—cases in which something must be done; cases in which, two or three years ago, the question of operation of some kind would have been considered by us.
>
> This treatment, it must be remembered, is a new thing. We began it in comparative ignorance. Electricity is known by its results, and, working on the living body, progress and improvement are slow. In the following cases, therefore, are found some failures and some imperfect and incomplete cases; the marvel is rather that there are so few. Time and experience every day correct our want of knowledge and diminish these imperfections. No large uterine tumor has, with us, entirely disappeared under the electric treatment, but in four cases of small fibroids, three of which come into the present series, there is not now a trace to be found.

---

[1] "Electricity in the Treatment of Uterine Tumors, being Part II of Contributions to the Surgical Treatment of Tumors of the Abdomen," by Thomas and Skene Keith, pages 255 *et seq.* Edinburgh: Oliver & Boyd, 1889.

The carrying out of this treatment faithfully to the end is not an easy matter, and old tumors that are large, and that have bled for many years, take a long time to improve. The treatment runs away with time, and it requires care and thought. To the surgeon, by far the simpler plan is hysterectomy and the removal of the ovaries. But Dr. Apostoli's treatment saves our patient from risk of life by operation, and saves them also from a horrid mutilation,—the one thing that they all dread. We believe it to be the right treatment, and our patients must get it, however great the inconvenience and monotony it may be to ourselves. Though our results after hysterectomy show the lowest mortality of any yet recorded, and though we have had but a single death after removal of the ovaries for fibroid in almost one hundred operations, we reject even the minor operation in favor of Dr. Apostoli's treatment, and we reject hysterectomy altogether on account of the mortality that has hitherto attended it all over the world. The method given us by Dr. Apostoli is good, and it will endure.

In dedicating this work to Apostoli, the elder Dr. Keith, who has since passed to the great majority, leaving with us an ever-living memory of unsurpassed skill, exalted courage, and unflinching honesty, makes some additional statements which might be taken as a final testament of a long and honored career concerning this matter:—

Since we began your treatment, now more than two years ago, we have ceased to perform any operation on the uterus by abdominal section. For myself, I have always had grave doubts if I were justified in performing such operations at all, especially hysterectomy, for the mortality attending this operation is out of all proportion to the benefits received by the few. As time went on, and the number of operations became larger, my doubts as to whether I were doing right continued to increase, and that, too, in spite of the comparatively low mortality with which I was favored, more especially in my private practice. I never had any such doubts as to the propriety of performing ovariotomy, for, if ovarian cysts be let alone, death is almost certain, and even that is only reached after great suffering. With hysterectomy it is quite different. Hysterectomy is a hazardous operation for the removal of a tumor that, of itself, rarely shortens life. The minor operation, on the other hand,—the removal of the ovaries,—requires no surgical skill for its performance. It is a great mutilation to a woman, being simply castration; and women are beginning to find this out. It is not always successful in attaining its purpose, for you will find in these pages some cases narrated that were cured by electricity where operations on the ovaries had failed to give any relief.

Your method thus came to me at a very opportune time. You have taken away from me those anxious doubts and fears that had so long vexed me. For long I had hoped much from electricity in the treatment of fibroids, but had only met with disappointment till your method was made known to me. It is in every way a new method, and it belongs to you and to no other.

> You have worked in the true scientific spirit. For five years you labored quietly at your clinic, kept up at your own expense, and open to all, before you made your work known. When it was made public, and ought to have had from all a warm welcome, or at least a patient hearing and honest investigation, considering the magnitude of your work, it was received with unbelief and ridicule. In common with many, I regret the unfair treatment you have received in this country. In spite, however, of the ignorance and prejudice displayed, your work is every day making its way, and it is impossible to resist the accumulating evidence there now is in its favor. That you will, in a few years, see your treatment adopted all over the world I have little doubt.

The prophecy contained in the last sentence, quoted from Dr. Keith's work, has long since been fulfilled.

Mode of Action of Electricity.—Much misconception has existed as to the mode in which electricity is expected to act in these tumors, the original impression with many, uncorrected in the earlier editions of this work, being that the purpose of the applications was the physical, electrochemic decomposition of the tumor-substance. This, of course, can be done with a sufficient current-volume, but it would be followed by the formation of a sloughing mass of dead tissue surrounding the electrodes that would be dangerous in tumors situated within the body, as these are. What does happen as a result of the use of currents of far less volume and duration is a shrinkage of the tumor *en masse,* no greater shrinkage occurring in the parts nearest the special seat of application or puncture than in those situated most distant. It appears, therefore, that the nature of the response is essentially trophic, the passage of currents of sufficient volume through the tumor causing an inhibition of the proliferating power of its abnormal cells, followed by a retrograde metamorphosis, quickened tissue-waste, and absorption through the lymphatics and veins, particularly the former, with which these growths are abundantly supplied. Coincidently with this direct action upon the lowly organized embryonic tissue of the tumor, it is certain that an increased physiologic resistance of the healthy surrounding tissues (trophic stimulation) is promoted by the passage of the electric current, and, as the most plausible theory of the growth of these tumors involves a lessening of this resisting force as a primal cause, its stimulation must be essential to a cure.

It will be seen that the essence of this discovery of Apostoli is that electricity may be used to arouse the natural forces of the body to remedy a faulty cellular growth by simply reversing the conditions that made the growth possible. The absorptive powers of the tissues are well known, even unstimulated by electricity,—bone, cartilage, and tumor tissues aseptically buried in the flesh being readily disintegrated and removed; hence it is clearly seen that the most important element of the electric treatment is the *reversal of the formative conditions* of the neoplasm. The task of the physician is the selection of the cases in which this can be done and the determination of the dosage and methods requisite for each case.

The reduction in the size that follows shortly after commencing a treatment adapted to the special case results, also, in a progressive relief of the pain, tenderness, and other pressure symptoms due to the growth. This early relief of pain and pressure symptoms must be partly due to the shrinkage alone, the nerves and organs that had been stretched and pressed upon being capable of adapting themselves to a still abnormal condition by reason of the partial relief afforded; but much of the symptomatic improvement must be due, also, to an electric stimulation of the physiologic resistance opposing the growth, as evidenced by a lessening of any surrounding inflammation, restoration of pelvic and abdominal tone, and even increase in the thickness of the abdominal wall.

In addition to the arrest and retrogression of the growth and the relief of pressure and inflammatory symptoms, an even more important and equally certain result is the cure of the hemorrhagic symptoms that attend so many of these cases. This hemorrhagic tendency, which sometimes assumes alarming proportions, is due to one or both of two characteristics: either a fungous endometritis (adenomatous degeneration of the endometrium) or to a hemorrhagic tendency of the tumor itself. That curettage is useful in correcting adenomatous degeneration is unquestionable, but it exerts no control over what might be called the essential hemorrhagic tendency of a fibroid; hence is far inferior to electricity as a hemostatic in such cases. The slowly produced effect of mercurial cataphoresis is, moreover, more certainly and permanently curative of the fungous condition even than curettage, by reason of the more effectual eradication of the matrices of the growth. To effect this the electrode must be most thoroughly applied to all portions of the endometrium by the sectional method devised by Apostoli, in which a bulbous anode as large as can be inserted is carried to the fundus, and, after a suitable application there, is withdrawn a distance equal to the length of the active surface and the current again turned on, the procedure being repeated until the instrument again reaches the internal os on the way out. The hemostatic effect will be heightened if the additionally alterative action of a mercury-coated electrode is employed as active pole instead of platinum or carbon. In hemorrhagic tumors the action of electricity is, therefore, dual, the local effect on the endometrium being hemostatic and the inhibition and shrinkage of the growth being antihemorrhagic.

Selection of Suitable Cases.—All fibroid tumors in the early stages of their growth are suitable cases for this treatment, unless, indeed, where electric treatment in the pelvis is contra-indicated by reason of a purulent collection within this cavity. The presence of such a contra-indication is, however, infallibly announced by an aggravation of symptoms after the first few applications, and in the absence of this postapplicative reaction it may be confidently assumed that all tumors not yet emerged from the pelvis are amenable in a high degree to both symptomatic cure and anatomic arrest and lessening. Of tumors so large as to have emerged from the pelvis and become abdominal in situation greater care in selection is requisite before promising the best results, for it should be remembered that neither Apostoli nor other authoritative writers have claimed that all cases are equally amenable to electricity. After they have attained this size the intramural variety is most amenable to both amelioration and cure, though there are a certain number of smooth, monocentric fibromas of ball-like contour and firm texture that yield very slowly to anatomic change, even though they may be classed as interstitial or intramural because of a distinct situation within the uterine wall. In most of the slowly responding tumors of this character the uterine cavity is found stretched upon one side of the growth, the opposite wall being attenuated. When the cavity is more nearly central, and there are evidences of several foci of growth giving rise to a multinodular surface, the case is a most favorable one for marked diminution as well as symptomatic cure.

Distinctly submucous tumors are also suitable cases, the current arousing the contractile action of the encompassing muscular fibers as a re-enforcement of the special denutritive effect, and such tumors are thus brought farther into the uterine cavity, becoming more pedunculated.

Subperitoneal tumors, particularly when pedunculated, are not easily reached by effective applications unless imprisoned in Douglas's pouch, when they may be brought under the electric influence by vaginal puncture through the median line of the posterior wall of the vagina. When a subperitoneal tumor is very large and abdominal in situation, and lying directly beneath the abdominal wall, abdominal puncture by the method described on page 162 may be used.

Contra-indications.—Fibrocystic tumors, or unusually soft myomas, contra-indicate the intra-uterine and puncture methods, and the same is true of all fibroids complicated with acute or purulent lesions within the pelvis or with abdominal ascites. Nonpurulent inflammatory troubles in this region also contra-indicate both of these methods at first, but do not contra-indicate vaginal treatment, under which they may so far improve as to make the more vigorous methods subsequently admissible. A successful case of destructive electrolysis of an intra-uterine fibrocyst is described on page 182, but the method employed was totally distinct from the Apostoli treatment, and the excellent result attained does not, therefore, controvert these conclusions. Unless we are in a position to dissolve and drain away the fibrocyst under full antiseptic precautions, as was possible in this case, the ordinary effect of electricity in promoting tissue-change is detrimental in the presence of the clogged lymph-spaces and deficient lymphatic circulation that is peculiar to this form of degeneration.

Methods.—Bearing in mind, on the one hand, that the current should be concentrated as near as possible to the matrix of the tumor, and, on the other, that it is not always necessary to produce a lesion of the mucous membrane in an inaccessible locality, it follows that the best methods in the majority of cases are: either intra-uterine applications, with as large an active surface within the uterus as can be inserted, or vaginal puncture. It has not been my experience that vaginal puncture offers any quicker results than the intra-uterine treatment in interstitial or intramural tumors with accessible cavities, and I reserve it, therefore, for cases in which the intra-uterine treatment is impracticable or is clearly inefficient by reason of the growth being subperitoneal.

Intra-uterine Applications.—*The intra-uterine method is therefore the method of choice in most cases,* both for theoretic and empirical reasons, and is the method particularly associated with the name of Apostoli. Its employment for fibroids does not differ in technique from that described on page 70, to which the reader is referred, the special directions for the treatment of hemorrahgic cases being given on page 123. An important detail to be observed is to employ as large an instrument as can be inserted, in order that the local action shall be equally applied to the cavity. In many cases we are compelled to rely on the rigid sound-shaped electrode (Fig. 31), because nothing else can be inserted. This instrument, like all others used, should be properly curved, asepticized, and the insulation[1] renewed and carefully inspected before each insertion, the shellac or sealing wax being carried down to a point that will bring the bare surface entirely within the internal os to avoid the formation of late atresias. Whenever it can be inserted I, however, prefer to employ the cotton-covered elastic platinum electrode (Fig. 32), or in hemorrhagic or endometritic cases a suitable size of the zinc-mercury electrode (Fig. 34), as positive pole, for recent experience has aroused a strong suspicion that the nascent oxychloride of mercury and zinc is of additional service in promoting arrest and absorption of the growth. When employed it should be freshly amalgamated previous to each application, to favor as great a dissemination of the mercury as possible. This necessitates the invariable employment of the positive pole,[2] even in nonhemorrhagic cases, it is true, but the denutritive effect is certainly greater than with the simple negative pole, besides the comfort to the physician of the knowledge that he is employing a most powerful antiseptic agency coincidently with the arresting treatment *per se*.

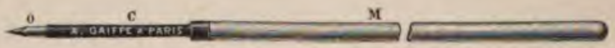


Fig. 47.—Apostoli's Vaginal Puncture Trocar, for Use with Handle Shown in Fig. 30.

Vaginal Puncture.—Reserved for subperitoneal tumors of pelvic situation, or interstitial growths with inaccessible cavities, this method should only be employed through the posterior vault of the vagina owing to the near situation of important structures in other portions of the pelvis. Apostoli originally employed for this purpose a large trocar with a shoulder limiting its insertion to either a half or one centimeter, the vagina being protected by a movable sheath of hard rubber or glass; but after 1892, possibly owing to the author's advocacy of a completely insulated puncture track, or buried puncture, in the earlier editions of this work, he employed the trocar shown in Fig. 47, with the sheath and handle shown in Fig. 30. The latest model of the author is shown in Fig. 48, in which the limiting shoulder of Apostoli is added, but the insulation is fused freshly for each application on the shank of the trocar itself, doing away with both the tube and the awkward edge of insulation, which hinders easy insertion, and securing *absolute* asepsis. As the author invariably employs the negative pole, the instrument is preferably made of steel.

---

[1] Shellac or sealing wax fused on the shaft.

[2] This instrument may, of course, be employed as a negative electrode if desired; but no diffusion by cataphoresis then occurs.

The insulation is of hard rubber, a stick of which is set on fire and applied to the heated instrument while burning, the coating being then re-fused and made smooth in that way. When done carefully, the coating is continuous back of the bare surface at the point, the small shank in front of the shoulder being brought up to the diameter of the point by its thin coating, which continues back over the shoulder on to the main shank without break.

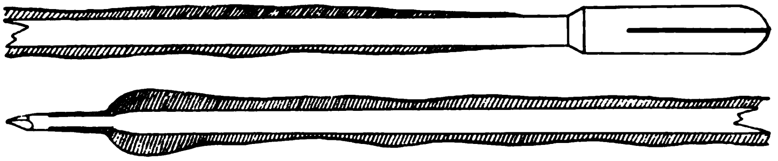


Fig. 48.—Author's Vaginal Puncture Trocar (Enlarged Sectional View).

The instrument being thus freshly asepticized, as well as insulated, the vagina is douched with a bichloride or other antiseptic solution, and with the patient in the dorsal position, the hips resting on a firm table or operating chair, the instrument is inserted with the point resting in the palmar surface of the index finger, thus shielding the vagina. Reaching the projecting portion of the tumor at a spot previously determined on, the point is carried forward and pressed firmly into it through the vaginal wall, an assistant meanwhile steadying the tumor from above. When the full insertion is made and the abdominal pad placed the current is turned on until it registers between 100 and 200 milliampères, negative. The duration of the application is the same as within the uterus.

The act of puncturing the vagina gives rise to considerable pain, but most women are easily able to bear it, and the subsequent action of the current is no more painful than in the intra-uterine applications, if the active surface of the electrode is carried well beyond the mucous membrane. Some of my punctures have been made under anesthesia, but I prefer to do without general anesthetics, when practicable, on account of full anesthesia being necessary to obviate the troublesome movements of a partially anesthetized person. While withdrawing the instrument the finger should be pressed against the vaginal wall alongside of it as a support, the insulated portion having a tendency to stick fast. Antiseptic douches will usually be the only after-treatment required, in addition to rest and hot applications for the relief of pain, should it appear. In case the puncture is made in the physician's office the patient should be sent home in a carriage.

These punctures may be made as frequently as three times a month. I have myself made them twice a week for a time, a slightly different spot being selected on each occasion; but when employed so frequently the physician should be on the lookout for a local reaction, which should be the sign for a cessation of the treatment until it has subsided.

Buried vaginal puncture will reduce fibroids and remove pain when the intra-uterine method is not tolerated. I have, moreover, never had a mishap or bad effect from its use, though this may be attributable to a careful selection of cases, as I can well conceive that the procedure might result in injury to important organs if employed in any case other than those in which the tumor is accessible by virtue of a practical protrusion into the posterior vaginal vault.

Abdominal Puncture.—Where the tumor is so large as to be abdominal in situation and not readily reached through the cervical canal or by vaginal puncture I have found it expedient to puncture through the abdominal wall by a method that I devised and described before the American Electro-Therapeutic Association before learning that the late Dr. Freeman, of Brooklyn, had employed a somewhat similar method in a cruder form. The fact that Dr. Freeman never published anything relating to his work had left the subject of abdominal puncture of fibroids represented in literature only by the exceedingly crude and unscientific work of the early 70's, when uninsulated electrodes resembling bayonets were used, with which the unfortunate patients were transfixed. To the bayonets was attached a battery consisting of a single cell. The infinitesimal current that was used in this harsh method, coupled with the fact that the work was done in the preantiseptic times, caused a mortality altogether out of proportion to any good results, and has given a bad name to abdominal puncture that is totally undeserved. These tumors are beneath our hands when they have risen entirely into the abdomen, with only the abdominal wall and two layers of peritoneum intervening. As contrasted with the pelvic route, scientific puncture from this direction is free from the embarrassing neighborhood of important organs if no intestines are in the way, is direct and exact, but possesses the one disadvantage of being intraperitoneal. By the expedient of employing only insulated electrodes to protect all tissues above the tumor the two pricks made by the needle in the peritoneum heal immediately, and in several hundred punctures made by me by the method described below there has not been a single instance of untoward results of any kind, and no evidence that any puncture resulted in adhesions.

The details of the procedure as devised by the author are as follows: The punctures being invariably negative, small steel needles are used, three at each puncture, attached by branch wires to a single pliant copper wire as a conducting cord (Fig. 49). No. 24 or 26 insulated wire is much more convenient than an ordinary conducting cord. For the puncture needles there can be no better form devised than the straight Hagedorn surgical needle found in every instrument shop. These needles possess the advantage of great ease of penetration, combined with lightness and strength, and the slit puncture made by them admits the increased bulk of the covering without hitch. This slit form of puncture also heals easily without a scar. The needle should be about three inches long, the first half-inch from the point being left bare and the remaining portion covered with hard rubber vulcanized on the shank as thinly as consistent with good insulation.[1] It is easily attached to the copper wire by the latter being passed through the eye and wound around the shank in contact with the metal. With the patient lying upon a large pad attached to the positive pole, these needles, properly insulated, sterilized, and attached to the negative pole of the battery by the branched wire, are easily and painlessly thrust into the tumor through the skin, the surface having been previously rendered surgically clean. Just before the insertion of each needle the spot selected should be anesthetized by a chloride-of-ethyl or rhigolene spray. The current-strength has varied in my punctures between 60 and 200 milliampères, and the duration from six to eight minutes. After the removal of the needles the minute spots made are sealed by the application of collodion. As to frequency, it is probably best to allow at least one or two weeks to elapse between each application of electricity in this manner, although this depends on the size of the tumor and the field of tumor surface accessible to the method. *It need scarcely be said that no punctures should be made at any spot that might be covered by intestinal convolutions.*

---

[1] The insulation and reinsulation should be done before each puncture, by the physician himself, to insure asepsis from heat and soundness of the covering. Melted hard rubber from an old thermometer case set on fire will adhere to the needle if the latter is heated.

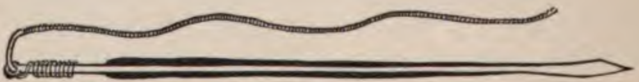


Fig. 49.—Author's Abdominal Puncture Needle (Shown in Enlarged Section).

The immediate inconveniences that follow these punctures, such as tenderness and pain, are generally less than those following an intra-uterine application. As a measure of precaution, some patients under this treatment have been kept in bed in the sanatorium or hospital for twenty-four hours after each puncture, but others have been treated by puncture at the office or clinic and walked home shortly afterward.

The technique of puncture for fibroids having been given thus fully, it remains to be said that the author employs this method very rarely indeed in the treatment of these growths.

Vagino-Abdominal Applications. — Danion, a former pupil of Apostoli, has made the claim that mere vagino-abdominal alternatives are both sufficient and superior to the intra-uterine and puncture methods in the treatment of fibroids. This is unquestionably a mistake as a broad claim, for the greater resistance of the tumor-tissue compels the bulk of the current to pass around it when the active electrode is not within its substance. That this method may act effectively upon some tumors is nevertheless certain, and the author had, in fact, used it long before the claims of Danion came to his attention. It is indicated as the proper treatment whenever the more active methods are for any reason inexpedient or contra-indicated, as when there is more tenderness in the ovarian regions than would render intra-uterine treatment wise; when periuterine congestion or an old pelvic peritonitis with adhesions overshadow the tumor in the production of symptoms; or when the patient is so advanced in years or so feeble as to render more active treatment unwise. It may be also used with advantage in the intervals between the days of more active treatment.

In employing the alternatives the ordinary vagino-abdominal method is varied by leaving the electrodes *in situ* after turning the current off, reversing the polarity at the commutator, and then turning the current on again in the same gradual manner, repeating the procedure a number of times with a current-duration each time of about a minute. The advantages of this method are: greater contraction of muscular fiber by reason of the variation of potential being exactly double what it would be with the same current-strength without reversal, and a protection of the vagina from erosion, since the electrolytic action is nullified in each reversal. Its disadvantage compared with simple vagino-abdominal applications, which are, at times, preferable, is that the actions of electrolysis or cataphoresis are practically wanting.

Results of Treatment by Electricity.—A method designed for the relief of human ailments must stand or fall on its ascertained results alone, no matter how plausible may be the theory or hypothesis on which it is founded or explained. Tested by this rule, electricity in the treatment of fibroids has more than fulfilled the modest claims of Apostoli, for a much larger proportion of cases has been completely removed by absorption than was at one time thought possible, the extent of the original claims being merely a symptomatic cure and anatomic regression. Adhering to the rule of personal experience adopted in previous editions of this work, a tabulated list of one hundred and ten cases of fibromyomata of the uterus consecutively treated is given in the appendix, the results in many of which are stated at periods varying from two to sixteen years after the cessation of treatment. On analyzing this table, the items in which have been brought down to the date of publication of the present edition of this work, so far as possible, by personal inquiries, letters, and circulars to former patients, the following results appear:—

Cases resulting in anatomic and symptomatic cure:—		
(a) Destroyed piecemeal by electrolysis through cervix	1	
(b) Extruded through cervix in whole or part	3	
(c) Disappeared by absorption	18	
Cases resulting in symptomatic cure:—		
(a) With great reduction in size	12	
(b) With slight reduction in size	26	
(c) Without change in size	15	
Total cases resulting in practical success		75
Symptomatic improvement only	16	
Failure to effect any change	9	
Made worse	1	
Total cases resulting in failure to relieve		26
Ultimate results unknown		9
Total cases		110

In computing the percentages of these results it is but just that the nine cases in which the ultimate results are unknown should be eliminated from consideration on account of the fact that these cases were all dispensary patients who received but little treatment, it being, in the absence of definite information, as likely that this little amount of treatment relieved their pains and thus caused them to be careless about returning as that the results were only negative. Deducting these cases leaves one hundred and one cases in which the results are sufficiently definite for statistical purposes.

Of these 101 cases, 75 were practical successes and 26 practical failures. The teaching of these statistics appears to be, therefore, that 75 per cent. of all cases treated by the Apostoli treatment will be practically cured by it, but that it will be of no permanent benefit in the remaining 25 per cent.

The one case that was made worse was a cystic intra-uterine growth that was improperly treated by electricity very early in the history of this method and before it was generally known that such cases should not be treated by the now classic intra-uterine method. Future statistics will naturally be clear of this source of error, as well as those arising in attempts to affect subperitoneal tumors favorably that are inaccessible to direct applications. And, even if no improvement be made in these figures in the near future, it is a distinct satisfaction to the conservative physician to reflect that in the 25 per cent. of cases in which electricity does no good it can be relied on to do no harm in proper hands, leaving the tumors unchanged for the trial of other methods. The slight responsibility in advising electric treatment is therefore evident.

On the other hand, the question is a far different one when the surgical removal of these growths is considered. With a mortality of one in four in the most skilled hands,[1] the physician assumes a serious responsibility who advises a resort to this method before the value of electricity has been tested in the case.[2] There is no appeal from surgical failure. It should be the court of last resort.

And, while lack of space forbids a complete discussion of the relative disadvantage of other methods, it may be said that a marked contrast exists also between the cases successfully treated by electricity and surgery. Successful removal of the tumor necessitates removal of the ovaries also, thus destroying the distinctively feminine characteristics of the individual; produces a weak spot in the abdominal wall leading to hernia, which is practically far worse a tumor than the original fibroid; and in some cases produces painful neuroses due to cut nerves, and even at times insanity. No such sequences attend a successful electric treatment, which invariably restores the patient to robust health and almost as invariably checks further growth of the tumor, even in cases where more or less of the tumor remains after treatment as a harmless lump of flesh.

Nineteen of the cases tabulated in the appendix deserve a report in full,—namely, the eighteen cases in which the tumor has disappeared by absorption and one case in which an intra-uterine cystic tumor was destroyed by intra-uterine bipolar electrolysis.

---

[1] Pozzi ("Clinical and Operative Gynecology," American translation, volume i, page 310) gives a percentage of 25.80 of deaths in a list of 345 operations in the most skilled hands.

[2] A distinguished surgeon, now deceased, advised an operation in one of the author's cases. On being appealed to whether he would not have electricity tried if she, the patient, were his daughter, he at once assented and referred her to the writer, who has had other evidences that a higher conception of advisory responsibility prevails among physicians when members of their own families are involved.

Case No. 1.[1]—An unmarried lady of 45, a patient of the late Prof. William Goodell, who had diagnosed a fibroid tumor four years previously, was admitted to my private sanatorium February 11, 1888, suffering from general impairment of health due to a tumor (Fig. 50), about 5 by 3 inches in dimensions, developed from the right wall of the uterus, apparently in the broad ligament. As there was a sharp turn in the upper portion of the uterine cavity it was thought at first that the tumor was broadly pedunculated, but

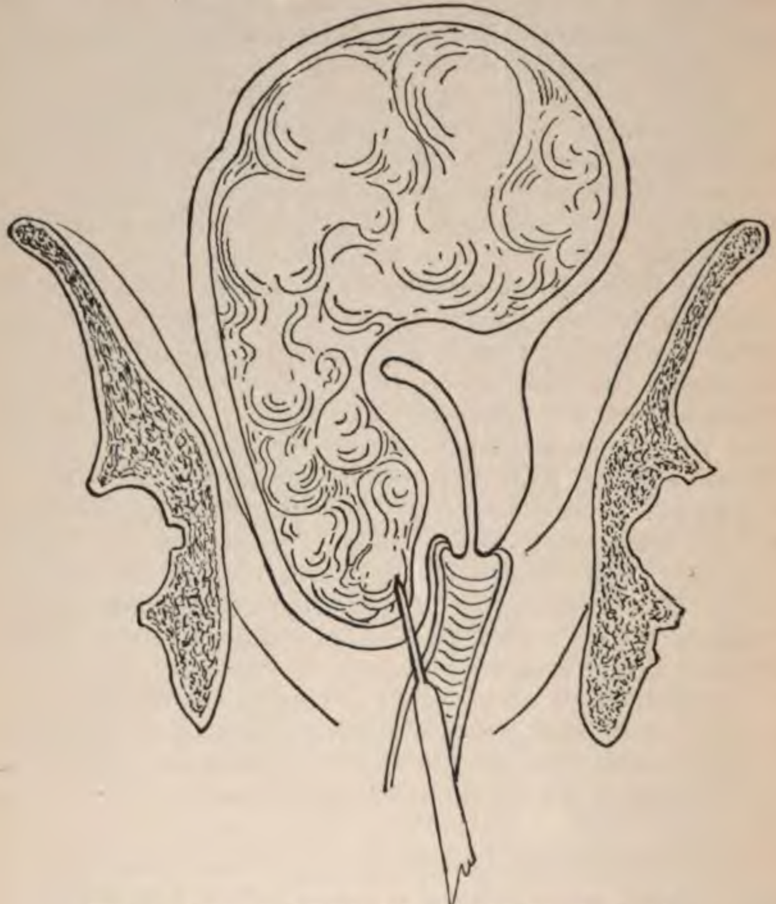


Fig. 50.—Diagram of Original Outline of Tumor in Case 1.

---

[1] The numbers refer to the tabulated list contained in the appendix.

subsequent exploration of the cavity proved that it extended a considerable distance to the right, and that the growth still formed the right wall of the uterus, which it had pressed very much to the left. As a downward prolongation of the growth could be easily felt close to the right vaginal wall, it was punctured in this situation and 150 milliampères, negative, applied. This was repeated four times, with a resulting diminution in the projecting portion of the tumor. Three years subsequently the patient came under observation again with a continuance of menorrhagia and no reduction in the upper limit of the growth. Under improved technique an electrode was now passed four and one-fourth inches to the fundus and a series of positive intra-uterine applications made, varying in strength from 30 to 100 milliampères, the tumor becoming progressively smaller. The patient reports, recently,—over sixteen years after the punctures,—that she is unable to find any sign of it and is in perfect health, and the author has repeatedly verified the statement by personal examination.

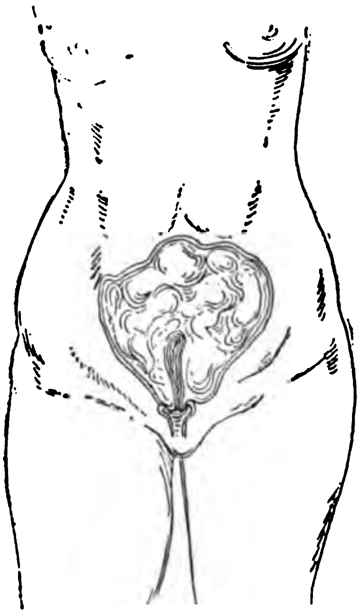


Fig. 51.—Diagram of Original Outline of Tumor in Case 5.

Case No. 5.—A married woman of 38 was kindly referred to me for electric treatment by Dr. T. Hewson Bradford, of Philadelphia, early in 1888, at the Out-Patient Department of the Pennsylvania Hospital, at a time when clinical material was very valuable in testing the then novel statements of

Apostoli. The growth consisted of a hard, irregular, multiple mass occupying the lower half of the abdominal cavity, a central nodule extending two inches above the navel (Fig. 51). The main portions of the tumor lay to the left of the median line. The os was patulous, but lay so high in the vault of the vagina as to be reached by the finger with difficulty. Menstruation was regular, but profuse, and attended with severe pain at the beginning and end of each period. Owing to pressure, walking was difficult, and there was much swelling of the legs and feet.

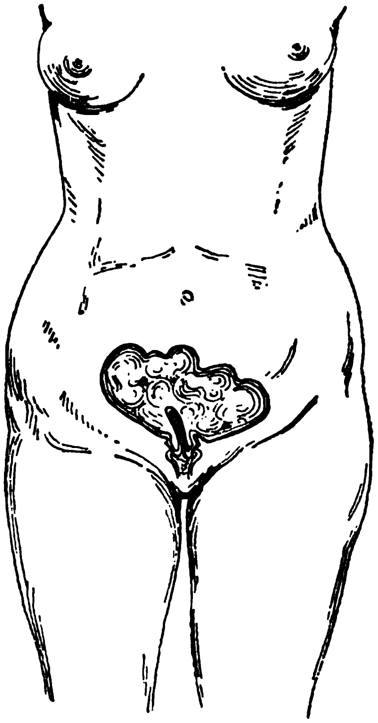


Fig. 52.—Diagram of Original Outline of Case 6.

The treatment was at first by the negative pole, as this was early in the application of the method, with currents varying from 60 to 150 milliampères, resulting in some uncomfortable sanguineous flows; but after five applications at appropriate intervals a distinct lessening of size was noted, enabling the patient to wear dresses as much as four inches smaller at the waist. The improvement continuing, the patient shortly after ceased treatment and took a position as cook in a large family. Eight months later there was a return of pain and tenderness without increase in size, and, as it was desirable that rest should follow each application, she was admitted to the house department of the Howard Hospital and treated for six weeks with currents of 250 milliampères. At the end of this time she could lie on the stomach for the first time in years, and the upper limit of the tumor was two inches below the navel. She was seen five years later by one of the hospital nurses, to whom she declared that the tumor had entirely disappeared.

Case No. 6.—A single woman, aged 41, was referred by Dr. Frank Woodbury, with a history of hemorrhages twelve years before, at which time the tumor was first discovered. The menorrhagia had ceased for some time, but she was troubled with menorrhalgia and a most offensive leucorrhea. The pelvis and lower third of the abdomen were filled with an irregular, hard mass, extending nearly to the navel, and separated by deep sulci into three lobes (Fig. 52). The os was found with difficulty, but was so stenotic as to foil all attempts at inserting a sound or electrode. An unsuccessful attempt was made to insert a steel needle into the tumor through the abdominal wall, developing the fact that the tumor had undergone calcareous degeneration in its upper portion. A filiform sound was now passed two and a half inches into the cavity and 60 milliampères applied successfully. Two days later a No. 18 wire, tipped with solder, was inserted, and a week later an ordinary sound, by which time the odor had disappeared from the discharge and never returned.

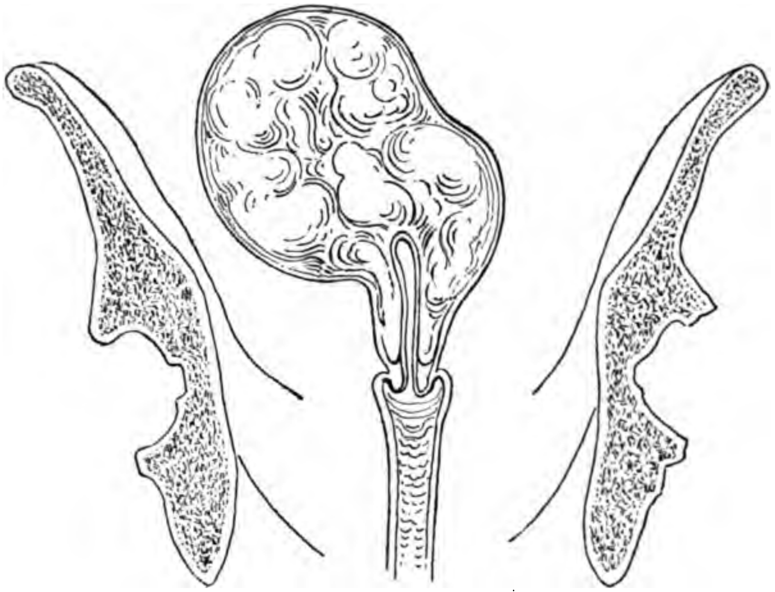


Fig. 53.—Diagram of Original Outline of Case 7.

The treatment was kept up for six months, as it was seen that a diminution was taking place, at which time her condition was as follows: General health much improved, no leucorrhea, no menorrhalgia, cavity of uterus normal, and tumor shrunken one-third. Instead of being three-lobed it now consisted of three distinct tumors, movable upon one another, showing that the absorption had doubtless occurred in the base where there was probably no calcareous change. She reported to Dr. Woodbury recently that the tumor had disappeared.

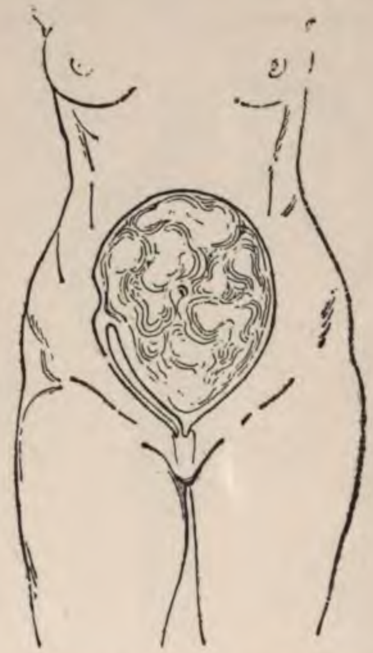


Fig. 54.—Diagram of Original Outline of Case 13.

Case No. 7, referred by Dr. Bradford, presented an interstitial enlargement of the uterus to the size nearly filling the pelvis, in a patient 34 years old. There was a subperitoneal projection on the right the size of a large orange, extending up into the abdominal cavity to a level with the anterior superior process of the iliac bone (Fig. 53). She suffered from a copious purulent leucorrhea and constant pain in the left groin, rendering walking difficult. The treatment consisted of intra-uterine negative applications, beginning with 50 milliampères and quickly increasing in subsequent applications to 150. Symptomatic improvement began very shortly and reduction in size was noted in the second month. The treatment was kept up about eight months. Examination subsequently showed a reduction of the uterus to normal and of the protuberant portion to a nodule no larger than a marble.

Case No. 13 was the wife of a physician in a Middle-Western State, aged 48, and was sent to the sanatorium by the late Professor Goodell as not suitable for operation. She was having alarming hemorrhages almost constantly, which kept her in daily fear of a fatal issue. The tumor was very large, fully as large as an adult head, and of the smooth, hard, monocentric variety, the cavity being spread out on the right side with an extremely thin wall on one side and a depth of five inches (Fig. 54). It had evidently developed in the left wall of the uterus and become submucous, but so large as to spread the organ out on its right. Treatment was commenced at once with a carbon electrode of large size, which was pressed into the tumor rather than applied to different portions of the cavity, as in sectional cauterization, on account of the very thin right wall. The hemorrhages being alarming and the patient more than usually impatient, the treatment was pushed most heroically,—some twenty-two treatments in fifty-five days: about every other day, since a period intervened during the applications. Nearly all of these applications were of 250 milliampères for the long durations of ten and fifteen minutes. As the hemorrhages were now arrested, she went home, but the natural result

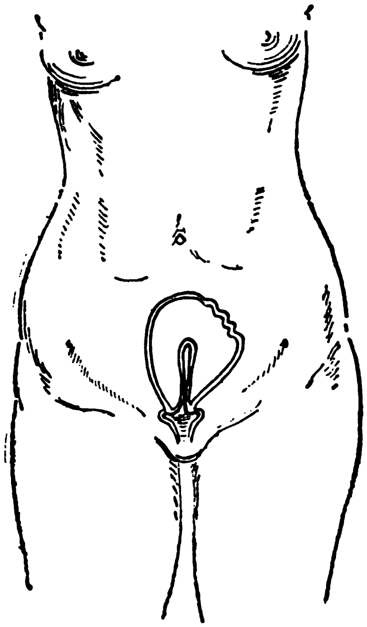


Fig. 55.—Diagram of Original Outline of Case 17.

of a tedious separation of a portion of the tumor followed, with slight rise of temperature. After this part came away the remainder of this large tumor slowly disappeared by absorption, and the patient, when heard from, sixteen years later, in March, 1904, was in perfect health, not a vestige of the tumor remaining.

Case No. 17.—This patient, a multipara, aged 34, was seen at the Howard Hospital, July 29, 1889, with a hemorrhagic fibroid filling the pelvis and extending above the level of the iliac bones. The upper portion was readily felt through the abdominal wall, being hard, somewhat flattened in shape, and with an irregular surface (Fig. 55). As the hemorrhage had lasted this time nearly two weeks, treatment was begun at once with a positive intra-uterine application of 110 milliampères and continued twice a week for two months. By September 27th, on which day the last application was given, 70 milliampères strong, the tumor was almost gone, her color was improved, and she was gaining flesh. As she did not return again to the clinic, she was specially sent for on December 12th, and the following note made after examination by several physicians present: "Examination shows no evidence of tumor. The only abnormal conditions present are a thickening of the cervix on one side, some fixation of the uterus, and slight leucorrhea. She states that her periods are regular, lasting but three days."

Case No. 20.—This case, a patient at the Howard Hospital, aged 30, presented a singular history, the exact stages of which are left somewhat indefinite, owing to her limited intelligence. On examination, August 12, 1889, the uterus was found so large as nearly to fill the pelvis, with a nodular outline at the fundus. The os was virginal and the cavity measured three and one-half inches. She had been complaining of painful hemorrhages every three weeks for two years. An intra-uterine application of 60 milliampères positive was made, and nothing further seen of the patient for over four months, when she returned, saying that it had caused pain twenty-four hours later, followed by a sanguineous discharge that continued three months, two weeks of which had been spent in a hospital. Still complaining of pain and leucorrhea, an examination showed that the tumor was much reduced (it is probable that a portion had been extruded). She was now placed on vaginal applications, which resulted in complete symptomatic cure by January 31, 1890, the leucorrhea being gone and the periods regular and painless. The hospital notes of this date say: "No sign of tumor except lumps in tubal region."

Case No. 22 was also seen at the Howard Hospital, September 18, 1889, with a fibroid tumor situated in the right wall of the uterus about the size of a goose-egg and giving a history of a year's duration, with irritable bladder and other pressure symptoms. The treatment was intra-uterine negative applications of 60 milliampères. Two months later there was considerable reduction in size. The notes say, under date of November 1, 1889: "Examination shows uterus quite small and movable; no evidence of tumor." This condition was found to persist a year and a half afterward on the patient being visited at her home.

Case No. 24.—This lady, a widow aged 41, presented a typical instance of a small, bleeding fibroid situated in the posterior wall of the uterus so near the cavity as to give rise to alarming hemorrhages out of all proportion to the size of the tumor. At her periods she stated that she lost as much as some do in childbirth. Two years previously she had passed a polypus, and the hemorrhage, pain, and tenderness had persisted since then, becoming worse of late. The fibromatous uterus was much enlarged, with a projection on the postero-lateral aspect and a cavity three and one-half inches in depth.

The treatment of this case lasted exactly three months, being positive intra-uterine applications of a usual strength of 100 milliampères with platinum electrode (the zinc-mercury method not having then been devised), and resulted in the complete cure of the pain and hemorrhages, disappearance of the tumor by absorption, and reduction of the cavity to two and one-half inches. Her general health, which had been much impaired by loss of blood, was completely restored.

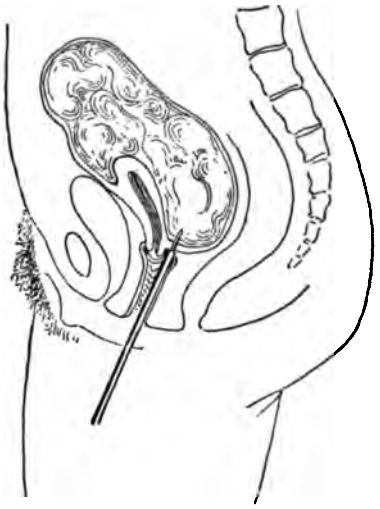


Fig. 56.—Original Outline of Tumor in Case 35.

Case No. 32.—Miss A. M. T., single, aged 46, was referred to me by Dr. Edward L. Duer, of Philadelphia, May 30, 1890, with a hemorrhagic fibroid filling the left side of the pelvis and extending into the abdomen to a point 3 inches below the umbilicus. She suffered from frequent attacks of pain in the left groin, and had numerous severe hemorrhages. The cavity was five inches in depth.

The patient was placed on biweekly intra-uterine positive applications, varying from 40 to 100 milliampères, which she faithfully kept up for ten months. During the following two years sixteen additional applications were made.

At the end of the fourth month of treatment there was great symptomatic improvement, but the tumor had receded but one inch at its upper limit. This improvement in the physical condition of the growth progressed slowly during the remainder of the treatment, no tumor being felt over the pubes at the end of ten months, and the cavity at this time measuring but three and one-half inches. At the end of one and a half years the tumor was scarcely perceptible by bimanual examination.

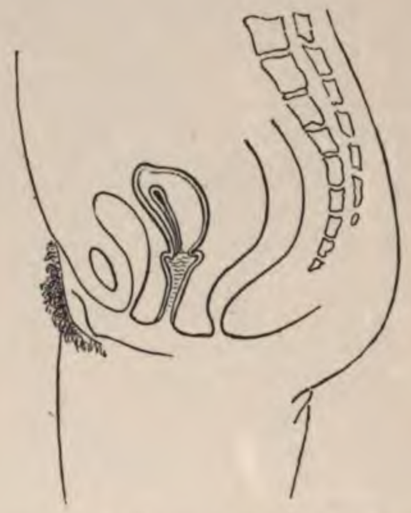


Fig. 57.—Outline of Tumor in Case 35 after Treatment.

At the present time, about eleven years after the cessation of the treatment, no tumor whatever can be found on examination, and the patient's health is excellent.

Case No. 35.—This lady was sent to me by Dr. Davis, of Bridgeton, N. J. She was 50 years old, and had been suffering from profuse and irregular menstruation for some time, but the tumor was not discovered until Dr. Davis found it to be the cause of an attack of retention of the urine. When admitted to the sanatorium,—October 17, 1890,—the uterus was found to be pressed against the pubes by a hard growth attached by a broad pedicle to its posterior aspect, and extending from a level of the os to within two inches of the navel. Another nodule was the size of a walnut and freely movable (Fig. 56). The cavity was over three inches in depth. As the bulk of the tumor was subperitoneal and the lower end was easily accessible through the posterior vaginal vault, the treatment was by buried vaginal puncture, negative, the needle being inserted from one to one and one-fourth inches beyond the vaginal surface. The punctures were all negative, and varied in strength from 100 to 150 milliampères, no anesthetic being required. In all, ten punctures were made, a diminution in size showing after the second. At the final puncture,—March 2, 1891,—the highest point was four and a half inches below the navel,—a reduction of two and a half inches in longitudinal diameter. On May 17th of the same year she returned by request, saying that it was impossible to feel any tumor through the abdominal wall. This was verified, no growth whatever being ascertainable by external palpation. The bimanual showed only a slight roughness at the fundus (Fig. 57).

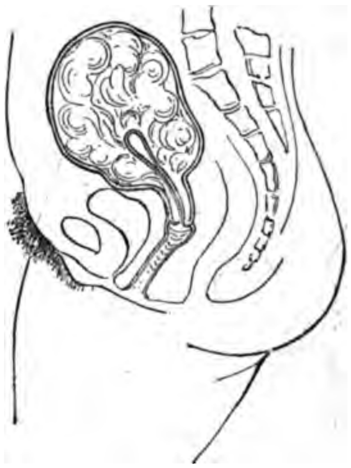


Fig. 58.—Original Outline of Tumor in Case 38.

In a letter dated February 4, 1904, about thirteen years after the cessation of the treatment, this patient states that there has been no return of the tumor, and that she had enjoyed good health since the date of her last visit.

Case No. 38.—This case is particularly noteworthy in presenting the history of the complete disappearance of the largest tumor that, so far as the author is aware, has been caused to disappear by electrically induced absorption without the assistance of the menopause. The lady in whose case this gratifying result has occurred was a widow 46 years of age, though since her restoration to health she has married a second time. She was first seen by the author on January 31, 1891, having been kindly referred by Dr. G. H. Whitcomb, of Greenwich, N. Y. The growth was at that time about the size of an adult head, the upper limit being about one and a half inches below the navel, hard, knotty, and freely movable in the abdominal cavity, in which it mainly lay (Fig. 58). Examination showed it to be continuous with the uterus, the cavity being in the anterior portion, distorted, and difficult of penetration; large projections extended to the right and left posteriorly. The patient said the growth had been discovered but three years before, though preceded by the intense menorrhspasms from which she still suffered. One year before seeing me she had been placed under electric treatment by Dr. Whitcomb, whose intelligent application of the Apostoli method resulted in great relief of pain and a reduction of size from one and a half inches above the navel to the same distance below that point. The treatment had been discontinued for some time before the case first came under my observation, but since her removal to Philadelphia there had been a recurrence of menstrual pain and swelling of the tumor, and she was also suffering from an edematous swelling of the right leg. The examination showed that the posterior projection, which was of more recent appearance, probably caused the edema by mechanically interfering with the venous circulation of the leg.

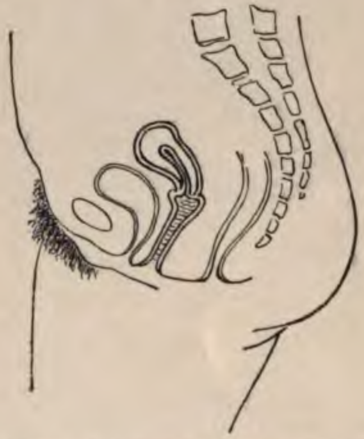


Fig. 59.—Outline of Uterus in Case 38 after Treatment.

She was placed on vaginal alternative applications of 150 milliampères and subsequently on a weaker intra-uterine dosage. In three weeks' time she was able to lay aside the elastic stocking that she had been wearing. During the following month, however, a typical attack of the prevailing influenza put her back somewhat, and I was afforded an opportunity of witnessing an example of the intense menorrhspasms with which she had been afflicted, accompanied by a swelling of the tumor to the level of the navel again. The treatment was, nevertheless, persisted in, and I had the satisfaction, some months later, of noting a great reduction. At the end of six months' treatment she was seen again by Dr. Whitcomb, who had some difficulty in finding the tumor. Six months later it had entirely disappeared (Fig. 59).

The case was examined recently by the author, thirteen years after the beginning of the treatment, and the uterus could not be distinguished from a perfectly normal one. The enormous, irregularly lobulated growth had disappeared. The patient menstruated normally until several years ago, showing that the result was not assisted by the menopause.

Case No. 46.—Mrs. C. M. W., aged 45, was brought to the sanatorium by her husband on March 20, 1891. She was a nullipara under the average height, and the immense size of the tumor, in conjunction with a lateral curvature of the spine, produced a most noticeable deformity. The tumor had been known to exist for fifteen years and had been accompanied by hemorrhages, the latter having ceased on appearance of the menopause six months ago. The menopause had not been of service in ameliorating the condition of the patient, except in the matter of stopping the hemorrhages, for her health was becoming worse and the tumor had made a distinct increase in size during the intervening six months.

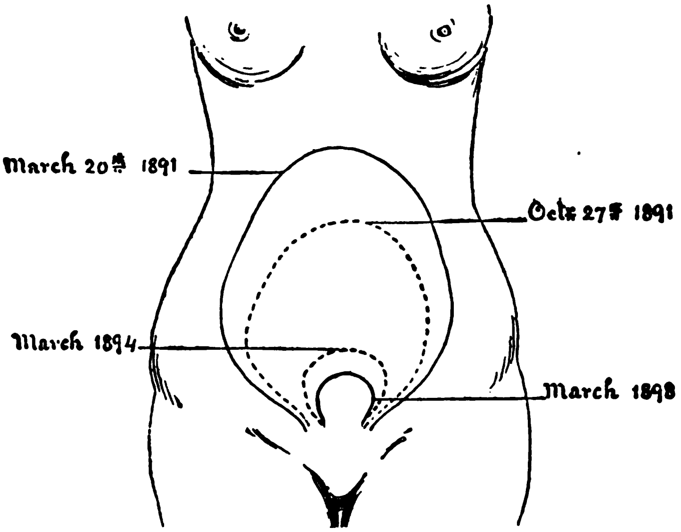


Fig. 60.—Outlines of Tumor in Case 46 at Various Dates.

The growth was somewhat larger than the uterus at term, extending four and one-fourth inches above the navel and increasing the abnormal waist measure to thirty-seven and one-half inches. It projected so far as to measure eighteen and one-half inches from spine to spine of the ilia (Fig. 60).

On palpation the tumor seemed so elastic that I at once suspected a semicystic nature. This was rendered more probable by the symmetrical and ovoid shape of the growth and the fact that the cavity could not be entered by a sound to a greater depth than three inches, the cervix being effaced. Under these circumstances my decision was announced that the Apostoli treatment would be inapplicable, and the patient was urged to consent to a consultation with a surgeon, the husband being sent for for the purpose of securing his acquiescence.

The lady, nevertheless, positively declined surgical treatment and begged me to do what I could with electricity. To determine the true nature of the growth it was decided to aspirate it through the abdominal wall. This was done on March 29th, withdrawing one and one-eighth ounces of a serous liquid that coagulated on standing. On microscopic examination by Dr. Alfred Stengel, of the University Laboratory, it was pronounced a mixture of blood and fluid from a broad-ligament cyst, though no proof of the latter was found. A second aspiration one month later withdrew two ounces of the same character of fluid. The fact that this liquid came from small cavities successively pierced by the needle was not out of keeping with other clinical evidences that the growth was a fibromyoma undergoing cystic change and increase in size, and the cavities seemed to be separated by trabecular processes. But probably the most distinct proof of its myomatous nature was afforded by subsequent evidence that showed that it would temporarily diminish in size under strong percutaneous currents.

These punctures for diagnosis having been so well borne and so easily made, owing to the absence of any structures between the tumor and abdominal wall, it was now determined to employ negative abdominal punctures after the method described on page 162. At the first puncture 60 milliampères were used with three needles. Three days later the measurements were three and three-fourths inches above navel, and seventeen inches between iliac spines; the circumference was not taken. This showed some diminution. The punctures were now made regularly at periods not less than two weeks, the current being gradually increased to 150 milliampères. On October 27, 1891, the tumor had decreased to two and one-half inches above navel, fifteen inches between spines, and thirty-five inches in circumference,—a very notable decrease in all measurements. The patient was also in greatly improved health.

The patient now came from her home in New York City for a puncture about once a month, the current-strength being from 200 to 300 milliampères, by triple puncture. The last puncture was made March 14, 1893,—two years after the first. In June of this year the tumor was even with the navel and the abdominal circumference was but thirty-two inches, in spite of much additional flesh in consequence of improved health. The patient continuing under occasional observation since the cessation of treatment, I have been able to add to the measurements in the cut (Fig. 60) that taken in March, 1894, when the upper limit was one and one-half inches below the navel and the circumference thirty and one-half. At the present time, thirteen years since the beginning of the treatment, no sign of the tumor can be found by the most careful examination, and the patient is in excellent health.

Case No. 49.—Mrs. R., aged 41, of Wilmington, Del., applied for treatment April 21, 1891. Full arrangements had been made by a surgeon to remove her ovaries the following week, the patient stating that this was a preliminary step to the repair of the cervix. On thorough examination the following conditions were found: The uterus was enlarged and tender, slightly anteflexed, with cervix pointing to the right. At the fundus there is a sessile lump about the size of a split walnut, moving with the uterine body when a sound was inserted into the latter. The parts were excessively tender, the tubal regions not presenting marked abnormality.

It was evident from this examination that a mistake in diagnosis had been made, the lump being a fibroid nodule instead of an enlarged ovary, and the general tenderness was associated with the tumor itself.

The patient was admitted to the sanatorium for daily vaginal applications of the constant current, followed by the induced, the former averaging about 50 milliampères. Later the positive applications were changed to alternative applications to lessen local action on the vagina.

There was a rapid improvement of the symptoms; so much, indeed, that the patient was shortly sent home with directions to come for office applications. One month later the conditions warranted intra-uterine applications of from 30 to 50 milliampères at appropriate intervals, which was continued for five months at increasing intervals of time. A few additional applications were made in the year following, resulting in complete restoration of health and a gradual diminution of the growth.

In a letter received from her in March, 1904, thirteen years after the beginning of treatment, the patient states that she has continued in the best of health, and can find no trace of the tumor.

Case No. 56.—Mrs. ——, aged 43, of Reading, Pa., was referred to me June 28, 1892, by Prof. William Goodell, the letter accompanying the patient giving the dimensions of the tumor as 4 by 5 inches. The patient was nearly exsanguinated, and was brought to tne sanatorium on a rolling chair, as she feared that walking would bring on a hemorrhage. For three years she had flooded two days every three weeks, and was extremely weak.

She was placed on positive intra-uterine applications of from 45 to 75 milliampères with a sound-shaped electrode, as the cervix was not greatly dilated. After a short stay in the sanatorium she was able to go to her home and return regularly for treatment, which was continued with increasing intervals for a year.

In a letter from her son, dated February 29, 1904, about eight years after the beginning of the treatment, the information is given that the patient remains in good health and can find no traces of the tumor.

Case No. 77.—Mrs. F., aged 43, was sent to me by Dr. W. S. Janney, of Philadelphia, November 14, 1895. She was suffering from copious menstrual flows every two weeks, with occasional hemorrhages. There was considerable tenderness over the location of the tumor, which was the size of a cocoanut, filling the pelvis and extending two inches above the umbilicus.

Treatment was begun with a small-sized zinc-mercury bulb, positive, with currents varying from 40 to 70 milliampères.

In two months' time the growth had shrunk to a level with the umbilicus. The treatment was continued during the following year, with a gradual improvement of all symptoms.

At the present time, eight and a half years after the beginning of the treatment, the patient is in good health and no sign of the tumor is manifest on the closest examination.

Cases Nos. 42 and 76 complete the list of tumors that disappeared by absorption, and are sufficiently described in the table.

Case No. 61.—Mrs. W. A. D., a nullipara, aged 39, was sent to the sanatorium on September 29, 1892, by Drs. Hemminger and Bixler, of Carlisle, Pa. The growth had been discovered by Dr. Hemminger seven years before. On admission the uterus presented a symmetrical enlargement about equal to the fifth month of pregnancy, elastic and semifluctuating in consistency. Through the dilated os a smooth elastic body presented, nearly the size of a child's head. This was the lower portion of a vasculo-cystic intra-uterine tumor that was found to be everywhere adherent to the interior of the uterus except around the internal os and for a small space anteriorly. The presenting portion projected about an inch beyond the external os; similar projections had been removed by Dr. Hemminger on two previous occasions by means of the écraseur. The patient complained of but little pain, but was disturbed by a most copious watery discharge and was much reduced in health.

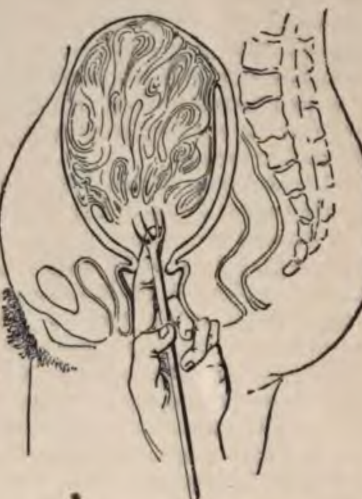


Fig. 61.—Original Outline of Tumor in Case 61, showing Method of Treatment.

The cystic nature of this growth clearly contra-indicated the ordinary Apostoli treatment, and after considerable hesitation it was determined to try a new method of electrolytic destruction with a bipolar instrument made especially for the case, each pole terminating in two needle points of platinum about half an inch long, the points being immovably fixed an inch apart. Before beginning this the écraseur was applied to remove the most projecting portion. This proved both difficult and dangerous, the material being exceedingly tough and the hemorrhage so frightful as to cause an abandonment of the operation. The electrolytic method (Fig. 61) was now begun, and from 300 to 400 milliampères employed for ten to fifteen minutes daily, without sensation to the patient other than slight internal warmth, followed by continuous irrigation with a weak solution of permanganate of potassium. As much as 700 milliampères was later employed, resulting in a material reduction by actual destruction of growth at each sitting, the uterus contracting as the material was dissolved. Not a drop of blood was lost. This treatment was kept up more or less actively for six months, or until May 9, 1893, when the following note was made: "Tumor all gone except base attached to anterior surface of cavity. The cervix admits but one finger. Other nuclei of fibroid growth are now shown to exist in the walls of the uterus, which remains longer than normal, but no larger than a small pear."

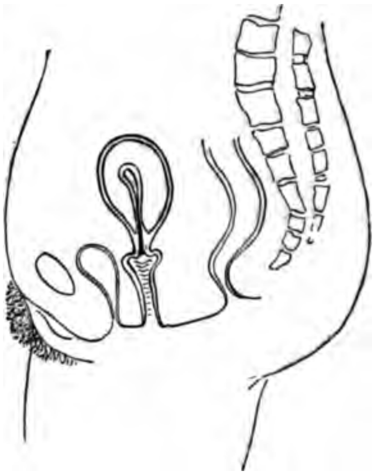


Fig. 62.—Outline of Case 61 in 1896.

An examination, made in the summer of 1896, showed a still further diminution in size of the uterus (Fig. 62) and the patient in good health. At the present date, more than eleven years after the beginning of the treatment, the patient continues in good health, and reports no evidence of the growth.

This case inaugurates a new method of treating vasculo-cystic intrauterine tumors that are accessible through the os, and it is a method that has several advantages over both morcellation and hysterectomy, the advantages over the former being its bloodlessness, the fact that septic absorption is rendered difficult by the electrolytic sealing of absorbents at the junction of the destroyed and undestroyed tissues, and the highly antiseptic nature of the products of electrolysis with so strong a current. Its advantage over hysterectomy is that the patient may get rid of the tumor and be restored to health without losing any of her organs, even the uterus.

Aseptic precautions are, of course, essential to this method of treating a cystic intra-uterine growth; but, when the immensely antiseptic effect of from 300 to 700 milliampères is considered, it amounts mainly to a problem of keeping the cavity aseptic between treatments.

This was done in this case by placing the patient on a rubber bedpan and douching the interior of the uterus with a gentle stream of strong, permanganate of potassium solution, maintained continuously for an hour, twice a day. Nothing less thorough would have preserved her from infection. The harmless nature of the solution employed enabled the injections to be kept up for months. The method is only possible when the cervix is dilated, as in this case.

In addition to my own cases thus summarized briefly and tabulated fully in Appendix A, I shall add a classification of the results reported by the Keiths in the volume referred to, as arranged by myself, for the authors of this most interesting narrative of case histories did not classify the results themselves, but apparently left this to be done by their readers.

Author's Classification of the Results in 106 Cases Reported by Drs. Thomas and Skene Keith.

Cases resulting in anatomic and symptomatic cure:—		
(a) Extruded through cervix in whole or part	3	
(b) Disappeared by absorption	3	
Cases resulting in symptomatic cure:—		
(a) With great reduction in size	47	
(b) With slight reduction in size	18	
(c) Without change in size	5	
Total cases resulting in practical success		76
Symptomatic improvement under insufficient treatment	8	
Symptomatic improvement only	13	
Total cases resulting in partial success		21
Failure to effect change		6
Made worse		2
Result unknown		1
Total cases treated		106

The present status of the Apostoli treatment of fibroid tumors is not completely shown without a reference to articles by Drs. Grand and Famarque, Dr. Apostoli's assistants in Paris, and by Dr. J. H. Kellogg, in the "International System of Electro-Therapeutics."[1] I reprint also a more recent and most interesting paper, read before the American Medical Association, at Baltimore,[2] by Dr. Lapthorn Smith, of Montreal, who was one of the first to employ the method in America, and who did more than any other to render it popular in this country by translations of the writings of its originator and by numerous papers of his own. Dr. Lapthorn Smith's testimony is the more valuable, nevertheless, as the judgment of one who, in addition to being a skillful user of the method, is a surgeon by choice and by reason of a large practice. Dr. Smith wrote as follows:—

> At the full flow of the tide of the most successful surgery the world has ever known one must possess a good deal of courage of his convictions to rise in the presence of such a distinguished audience as this to even discuss, far less to advocate, the treatment of tumors, even the most benign, by any other method than the surgeon's knife.
>
> Appearing on the programme of this meeting, surrounded, as this paper and its author are, by papers and surgeons advocating every kind of surgical treatment, from tying the uterine arteries to removing nearly all the pelvic contents, my position is a peculiarly difficult one: the more especially as I have been trained as a surgeon and now occupy a position as surgeon in several hospitals, where I am often compelled by circumstances to treat fibroids by surgical procedures.
>
> It is only fair that I should say at the outset that I did not choose this topic for my discourse; it was assigned to me by our esteemed chairman, who, in order to preserve the high reputation for impartiality which has been possessed to an eminent degree by the chairmen of this section of the Association in the past, no doubt wished that justice should be done to all methods of treatment at present employed. So strong is my own personal taste for surgery, especially of the abdomen, that I might have been tempted to disobey the chairman's command but for one reason, which was that as I reflected upon my work during the past seven years there passed before me the images of some fifty women whom I had treated for fibroids by electricity: first, as they appeared when I saw them, with faces anxious with

---

[1] "International System of Electro-Therapeutics," edited by H. R. Bigelow and G. Betton Massey. Philadelphia: F. A. Davis Company. Second edition, 1901.

[2] Journal of the American Medical Association, August 10, 1895, volume xxv, page 226.

pain and blanched from hemorrhage, and then after their pain had been relieved and their bleeding had been stopped by galvanism and their cheeks had resumed a rosy hue; these fifty women's faces encourage me to do justice, though the heavens may fall, to the treatment which has cured them.

Then there pass before me the dying faces of *ten* women who were treated by total extirpation, at two of which operations I was the executioner; at six of which I was first or second assistant, and at two of which I was only a spectator.

True, the majority of the ten operations were performed in the preantiseptic days, though by a great master in this department of our art; but four of them were performed within the last few years under the most rigorous aseptic precautions by men who have a small mortality in general for abdominal surgery.

The memory of these fifty women who have been cured by electricity, many of whom I could find, if required, and many of whom to this day stop me in the street to thank me and it for their rosy cheeks; and the memory of those ten women who are now no more, all tell me that I would be a traitor to the cause of truth if I remained silent, not only out of season, but in the very hour when it most needed to be spoken.

True, I can quiet my conscience when circumstances compel me to operate, by the reflection that one woman died while under electric treatment, not through electricity, but through an error of diagnosis, for mistaking a tense, impacted, liquid tumor for a fibroid, which would not have been made if the abdomen had been opened, or, in other words, if the treatment had been surgical instead of electric. This is the one and only case in which, as far as my experience goes, I have ever had seriously to regret the use of electricity.

I can still further soothe my conscience when I am compelled to operate, by remembering that I have operated on ten women, seven by abdominal hysterectomy, treating the stump by leaving it transfixed at the lower angle of the incision; and on three by removal of the appendages, tying the ovarian arteries low down; and several others treated in the latter manner, at which I was assistant, all of whom recovered and are now in good health.

When I visit the City of Brotherly Love, where the surgeons have declared war to the knife upon the electrode, I am often placed in an awkward predicament. When I tell my friend, Dr. Joseph Price, that I am going to spend a few hours at the electric clinic with Dr. Massey, he is surprised that a man of my intelligence can waste his time in such fiddle-faddling nonsense, and it is useless for me to assure him that I can show him many women in Canada, from Manitoba, in the west, to New Brunswick, in the east, who are pictures of health, and who have been cured by electricity.

On the other hand, when I tell my friend, Dr. Massey, that I am going to spend the morning with Dr. Joseph Price, extirpating fibroids, he looks with pity on my bloodthirsty taste and misguided energy. In vain I tell him life is too short to treat all my fibroid cases by such means.

In this somewhat peculiar position which I occupy, I have one consolation, and that is, or, at least, I hope that it will be so, that the conclusions which I shall presently lay before you are those of one who is entirely unbiased and nonpartisan, and are consequently to be accepted, as far as they go, in good faith.

My own opinion on the present status of electricity in the treatment of fibroids is fully made up, and I shall now endeavor to lay it plainly and honestly before you.

During the last year especially, although it has been growing gradually for several years, the conclusion has become evident that electricity is not suitable for every kind of case nor for every kind of doctor.

But it is as true to-day, as it ever was, that, for the cure of pain in and bleeding from the uterus, the application of the positive pole of the galvanic current, properly applied and of sufficient strength, to the uterine mucous membrane is, in the majority of cases, effective. The percentage of successes is greatest in those cases in which the fibroid growth is interstitial; not quite so great in the cases of submucous growths, although in several of these cases a few applications have been followed by the expulsion of the tumor from the uterine cavity. The earlier the cases come under treatment, the more surely they are cured, many patients with small interstitial tumors in the anterior wall having been completely cured by me, and still more under the care of others; so that the plea for the early treatment of fibroid tumors by electricity is quite as just a one as is the early plea for operative treatment. Indeed, it is even more so, for, while we can truthfully say that the electric treatment, when undertaken early and with a correct diagnosis, is at the present day entirely devoid of danger, no one can truthfully say the same of the treatment by operation. In fact, I am sorry to say that no one knows what is the death-rate of the latter treatment. Three of the ten deaths which I have above mentioned have never been reported, and six of them were only reported at my urgent solicitation.

May there not be many other similar cases? When a woman comes to a doctor for menorrhagia and he discovers a small fibroid, is he to urge her to submit to an operation, when he knows with the greatest skill and care she runs the risk of dying from the operation, and, if let alone, the death-rate is no more than 1 per cent., while with electric treatment the risk is absolutely nothing?

When she tells me that she will not submit to an operation, shall I assure her that I can do nothing for her, when I carry in my pocket the record of fifty similar or worse cases which have been cured by electricity? Surely that were dishonest! And yet the temptation to operate, in spite of the danger of surgical and the safety of electric treatment, is very great,—too great, in some cases, for us to resist.

Ours is a busy life, and there is not one of us here who has not often felt that life was far too short to accomplish all the good that we would wish to do, and, for the want of a few more hours in the day, much work of value to our fellow-beings must go undone. With this feeling strong within us, a poor woman applies at the out-patient department of our hospital with a small interstitial fibroid which has, however, doubled or trebled the bleeding surface of the uterine mucous membrane. We believe that we could cure her by a long and tedious course of treatment with electricity,—from ten to fifty applications; if there are no facilities at the hospital, then at our office. If at the hospital, the time required for this case would seriously encroach upon the time allotted to our service there; if at an office there is the same, as well as other, objections. And when we have made the sacrifice and cured the woman, what is the reward? Perhaps, but not always, the woman's thanks. Our own feeling of having done well, surely. But when we turn to our brethren, whose esteem is and should be the greatest incentive that we can look for, to good work, well and conscientiously performed, what do they say? We have no fresh and bleeding tumor to take to the medical society (as an Indian waves a white man's scalp), before our admiring brethren, as a trophy of our prowess and our skill. I have shown the women over and over again; I have shown their clothing which had to be taken in, as much as seven inches, owing to the decrease in size; the women themselves have offered to state on oath that their bleeding had been arrested, their pain removed, and their general health improved. How were these triumphs of therapeutic skill received? With loud applause, you will say. No, indeed! The praise bestowed upon the exhibitor of even an apparently healthy appendix, the removal of which was followed by the death of the patient, is wild in its enthusiasm when compared with the manner in which is received the report of a case of cure by electricity. Indeed, a sincere friend and admirer in our society warned me privately that my reputation was injured every time I showed a woman who had been cured by this means, and he urged me to show no more. But I must continue to cure them by that means as far as my time-limit and life-limit will allow.

How different when we report an operation, whether the patient lives or dies! Everybody seems pleased and praises us in proportion to the danger to which our patient has been exposed. But if she dies there are two, at least, who must regret that it was performed,—the patient and the doctor; and sometimes there are the husband and the little children to be thought about. But how much easier to take the patient into the hospital and in a few days perform hysterectomy, which we can do in a quarter of an hour sometimes. It is, as the French say, "*un mauvais quart d'heure*," but it is soon over and the patient's fate is sealed for weal or woe when we have put in the stitch which closes the peritoneal cavity.

After that the house-surgeon and nurses take care of her, and an average of three minutes a day for the next twenty days is the very most she requires of us. But with the electric treatment, what with getting the patient ready, carrying out the asepsis of the vagina, and adjusting the apparatus, I have spent as much as one hundred precious hours on a single fibroid case. But the ovaries remained and many of the women are now the happy mothers of children and others are happy wives, capable of having children, though yet childless.

I have lately asked several well-known men, men of the highest surgical reputation (you would be astonished if I mentioned their names), whether they had employed the electric treatment with good results, and they have assured me that they had, although they have never reported them; and when I asked them what was the principal objection to it, they replied, in confidence, that it took too much of their time. And this I admit is a serious objection to it, but not an insurmountable one. There are two ways in which it may be surmounted; one is by having an assistant whose time is less precious than our own, who has been trained to carry out the treatment with accuracy and care when we prescribe it for the disease which our more experienced touch has diagnosed. And the other is by having several rooms and a nurse to prepare the patient, including the antiseptic vaginal douche, and by devoting two afternoons a week, and having these patients come only at that time, as many as six treatments an hour might be administered.

Never before has it been so well demonstrated, as it is to-day, that by the division and subdivision of labor the workmen become more and more expert. It does not surprise me, therefore, that the best results of the electric treatment of fibroids are obtained by such men as Apostoli and Massey, who employ this treatment alone. They both obtain results which neither I nor any other operating gynecologist can hope for. In every large city we should encourage some one man to establish an electro-therapeutic clinic, where our poor patients, at least, might obtain the benefit of his skill in electric technique, after having obtained the benefit of our experienced diagnosis; in time, his reputation would reach the ears of the rich, and he would then have some substantial reward.

The present status of electricity is suffering as did the status of abdominal surgery a few years ago, because it has been tried by men without sufficient experience, and has, as a consequence, been found wanting. The electric treatment of fibroids requires knowledge of the pelvic contents as well as the electrician's knowledge of the power he is wielding.

I must trespass on your time yet a little more while I refer to two points. One, a claim which has recently been made by Apostoli for the electric treatment, which I can heartily indorse; and the other an objection which has been made to it, which I can as heartily deny.

Apostoli has discovered that the very failures of electricity can be turned to advantage in the following manner: It has been found that in those cases where the electric treatment has been badly borne and has been followed by febrile reaction, so that the patients have been turned over to the surgeon for operation, the presence of pus-tubes and pelvic peritonitis has been discovered. Apostoli has pointed out that electricity may be employed as a diagnostic agent for the purpose of detecting diseased appendages.

A remarkable instance of this came under my notice over a year ago. A young woman who had been employed in a restaurant in a New England town gradually lost her health, and had pain and hemorrhage. She suffered agony with her periods, which came too often and lasted long; so that her face was blanched and haggard. There was no difficulty about the diagnosis, as the tumor was large, round, symmetrical, in the median line extending up to the umbilicus, and could be easily seen and felt, bulging up the abdominal wall. Several physicians in the United States, her family physician in Montreal, as well as myself, all agreed that it was a fibroid. One of them had tried electricity several times, but always with bad results, and so did I. As she was laid up in bed for several days each time, I concluded that the appendages were diseased, and after three applications I decided to stop and to perform celiotomy. On opening the abdomen the tumor was at once seen surrounded by adherent intestines, but it still appeared a symmetrically pear-shaped fibroid. I could not, however, find the ovaries and tubes, and, while digging around for them, I made a line of cleavage which, being followed up, I was able to dissect out a portion of the tumor; it proved to be a sausage-shaped pus-tube; this was delivered intact, tied, and cut off. Then followed a large cystic ovary; then the other tube, which broke and inundated the field with pus; and then the other ovary, by which time the supposed fibroid was gone and only a moderate-sized uterus remained. The pelvis was carefully washed out and drained; the patient made a rapid recovery and is now at work and enjoying perfect health. So that, in this case, Apostoli's *dictum*, that when the application of his method causes febrile reaction the tubes are badly diseased, was fully borne out.

Now, the objection to electricity which has so often been made to it, especially by one of my most esteemed friends in Philadelphia, that it causes adhesions, is not true. I maintain that one has no right to bring that charge (1) if fibroids which have never been treated by electricity do have adhesions, and (2) if fibroids which have been treated by electricity can be proved not to have become adherent.

Now, I am in a position to prove both of these facts. When in Baltimore I saw the abdomen opened for fibroid, but it was so adherent to everything, intestine and abdominal walls, that the operator, one of the ablest in the world, did not consider it possible even to get the ovaries out, and the abdomen was sewed up. Now, this case, the most covered with adhesions I have ever seen, you will say, had received many applications of electricity, and so I thought, judging from these statements, must have been the case. But careful inquiry elicited the fact that she had never received a single application of electricity. But that is only negative evidence. Let us see about some positive evidence.

Three or four years ago I treated a lady, headmistress of a large public school a thousand miles away, for hemorrhage and pain, by means of intra-uterine positive galvanism. She had received one year's leave of absence from her duties and the commissioners had advanced her one year's salary in order to regain her health, she being utterly incapacitated for work. You may imagine that she was peculiarly anxious to get well, and therefore submitted to a very rigorous application of the treatment three times a week with great fortitude, as high as 200 milliampères being frequently given at a time. And this was not for one or a dozen applications, but for fifty times. By this time the bleeding and pain were nearly, if not entirely, arrested, and I advised her to complete the cure by a few months' rest at her old home down by the sea in New Brunswick. This she did and came back to me in July with rosy cheeks and sparkling eyes. She and I would have been perfectly satisfied with the result, and I should have reported her among my cures, had it not been for one thing, and that was that she asked me the question: "Can you promise me that the awful hemorrhages will not return after I have gone to my far-away home in the West?" This I could not answer her affirmatively.

Her next question was: "Is there any other treatment by which you can guarantee that result?" My reply was: "Yes, one only, and that is hysterectomy." Although the operation was not required by her then present condition, yet, owing to her financial situation, which would preclude her ever coming to Montreal again, at her urgent request I removed her uterus.

Now, if the charges against electricity have a vestige of truth in them, I must have found the tumor covered with adhesions; in fact, the tumor and appendages must have been one agglutinated mass requiring some hours of patient toil to detach them, and for this I was prepared. But what was my astonishment, on opening the abdomen and screwing a corkscrew into the tumor to be able to lift it out smooth and shining as the top of a bald man's head; the transfixing of it with pins and circling it with the serre-neud was the work of a few moments and in a minute more the tumor was off. She ran her 5 or 10 per cent. of risk of death safely, and made a splendid recovery and was at the head of her school once more on September 1st.

One such case carries more weight than a thousand assertions that electricity causes adhesions.

But I can duplicate it. A young lady who is now a trusted nurse in a New York hospital came to me, the first year I used this treatment, for hemorrhage and pressure symptoms caused by a large fibroid. She improved so much that I decided that she ought to go home by the time she had received fifty applications. But after the last application she began to flow before the time, and I asked her to wait until it stopped. It lasted seventeen days, a steady little stream of dark-red blood. I became momentarily discouraged and advised operation, which was accepted, but I handed her over to a more experienced operator than I was, at that time. I assisted at the operation and the tumor came out without the slightest difficulty, and was removed in the same way as the case mentioned above. I examined it most carefully and the only trace of an adhesion to be found was a spot about the size of a silver 5-cent piece, where the tumor had rubbed upon the brim of the pelvis on the right side and where she often complained of pain before coming to me. But there was not a sign of adhesion in the track of the electric current nor anywhere else except this one spot. The hemorrhage was due to a tiny opening in a sinus by the end of the electrode.

I dislike electricity, personally, because it takes up my precious time, but I want it to receive fair play and not be blamed for sins that are not its own.

There is one charge, however, which was frequently brought against the electric treatment of fibroids or rather against a method of applying it, in the past, and which was well deserved, but no longer applicable, because no longer employed. I refer to the method of galvanic puncture.

The greatest claim for the electric treatment of fibroids that can be made is that it has no mortality and that it is absolutely safe. If it is not safer than any other treatment, or, in fact, unless it is absolutely free from danger, there remains only one advantage in its favor,—namely, the saving of the ovaries. But galvanic puncture, no matter how performed, whether by the vagina or through the abdominal wall, must ever be a procedure fraught with danger, and is to-day practically abandoned. If anyone still uses it, in the cause of electric treatment of fibroids I beseech him to use it no more. The positive pole of the galvanic current gently introduced into the uterus will accomplish our object by unseen, but no less certain, means. It dries up the juicy, bleeding, mucous membrane, and, by its tonic action upon the muscular tissue through which must pass the vessels carrying nourishment to the tumor, its blood-supply is cut off just as surely as though we tied the ovarian arteries which supply the body of the uterus. The action of the electric current as applied to fibroids is threefold: The first is not mysterious; it is but the arrest of circulation in dilated capillaries by an electro-chemic cautery. The second is no more difficult to understand than the action of ergot or strychnine; it not only tones up the vasomotor system, making the caliber of the arteries less, but it calls into play the special and remarkable power which the uterus possesses of controlling its own circulation when it has the strength to contract. The third effect of the current, its electrolytic action, is, I admit, as mysterious as it has ever been, but not more so than the invariable absorption of syphilitic gummatous deposits following the administration of iodide of potassium. Whether what we call electrolysis means the actual breaking up of an organic tissue into inorganic atoms, or whether it means, as seems more likely to me, that the growth deprived of its blood-supply undergoes fatty degeneration and is partly eaten up by phagocytosis, stimulated to greater activity by the trophic nerves, no one with a large experience with this subtle fluid can deny that a uterus infiltrated with and enlarged by the deposit of fibrous tissue, whether localized in the form of fibroids or diffused, as in areolar hyperplasia, so that the sound will enter four or five inches, will invariably diminish in depth by means of electric treatment.

Then, again, what is the enormously enlarged uterus after delivery but a bleeding myoma? Does it not stop bleeding when the arteries which supply it with blood are squeezed by its contracting walls? Does it not rapidly get smaller when, for the want of blood and exercise, the immense mass of tissue silently undergoes fatty degeneration and returns to the blood, from whence it came?

Wonderful and almost incredible as the total disappearance of a fibroid or myoma may seem to some, it is no more mysterious than this wonderful process of nature which we call involution. Have those who doubt, and, even worse, deny the power of electricity to work a change in fibroids, never reduced the size and weight of a uterus which nature had failed to involute? Has Emmett never reduced its size by repairing a lacerated cervix? Have Churchill and Athill and ten thousand others with honored names never reduced the quantity of tissue in the uterus by the application of iodine? Have not a hundred thousand others ever reduced the weight of the blood and muscle and areolar tissue in the heavy uterus by means of glycerin and hot water and other therapeutic measures?

Then why, in the name of reason and justice, will you deny that an agent which we can see blanching tissues before our eyes, and making muscles of every kind contract, why will you deny, I say, that it can diminish the blood-supply to, and favor the fatty degeneration and absorption of, the fibrous or myomatous uterus?

The electric treatment of fibroids, reduced to the above simple equation and stripped of all the extravagant claims which were at first made for it, stands to-day upon a foundation so strong and true that it will find an honorable place in the treatment of fibroids as long as women shall dread to die by the surgeon's knife, which I believe will be as long as the world shall last.

These eloquently expressed convictions of Dr. Lapthorn Smith are so important that I deem it but proper that his paper should be quoted in its entirety, yet I must take exception to the adverse opinion expressed concerning electro-puncture. That this method is very rarely needed, and should be retained in the hands of experts only I will fully grant, but there has been nothing in my personal experience to condemn the method. To show that my position is borne out by the experience of others I will quote a paper from the Transactions of the Edinburgh Obstetrical Society for 1896-97 by F. W. N. Haultain, M.D., F.R.C.P.Ed., Lecturer on Midwifery and Gynecology in the School of Medicine of Edinburgh. The paper was read on March 10, 1897.

More than two years ago I gave an account of my experience in the electric treatment of uterine fibromyomata, with, perhaps, an enthusiasm as to the benefits to be derived from its employment which, from the somewhat limited number of cases cited, might be questionable. Since that time to this I have continued to follow this method of treatment in similar cases, with results so encouraging that any enthusiasm then shown in its favor is, if possible, more pronounced.

It is not my intention to dilate further on the general hemostatic and curative properties of the treatment, beyond mentioning that in these respects it has since amply fulfilled the sanguine expectations I then formed of its value; but it is my desire to place before you a record of three cases, treated by electro-negative puncture, which are, perhaps, of more than usual interest. They represent, I may add, my entire experience in this method of electric treatment.

Case 1.—Mrs. H., aged 36, had suffered for many years from a large uterine fibroid, which had, from the attendant hemorrhage, so reduced her health that Dr. Croom decided to remove her appendages. This he accordingly did on the 29th of October, 1893.

The operation, unfortunately, had no beneficial effect, either in arresting the hemorrhage or the growth of the tumor, and her condition went from bad to worse. From the extension downward of the tumor into the pelvis, pressure symptoms of a most exaggerated degree were developed. These consisted in complete urinary incontinence after previous retention, agonizing pains in the back, cramps of the lower extremities, and albuminuria,—probably the result of pressure on the ureters. At the same time profuse uterine hemorrhage rendered her exsanguine to a marked degree. Except under morphine, she had, for months, never been free from pain, and, quoting from her own words, she "frequently prayed for death to relieve her sufferings." During this period injections of ergotin and other forms of medicinal treatment had been assiduously carried out.

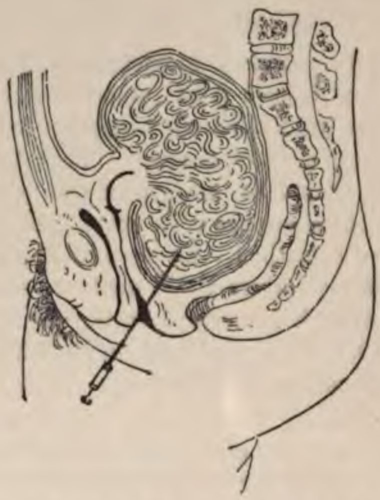


Fig. 63.—Outline of Tumor in Case 1 of Dr. Haultain's Before Treatment. (*Haultain.*)

By Dr. Croom's request I was consulted by her on the 7th of December, 1894, as, before undergoing hysterectomy, which had been recommended, she wished to know if electricity could be of any benefit. Though apparently hopeless, I determined to at least give her a trial of the electric treatment. In this determination I was supported by Dr. Milne Murray, who saw the patient, and of whose opinion I gladly availed myself. The local condition, on examination, showed the true pelvis to be filled with a tumor, which encroached on the vagina to such an extent that it was impossible to reach the cervix, which was high above the symphysis pubis. The upper border of the growth reached to three fingers' breadth above the umbilicus (Fig. 63).

On the 14th of December I commenced the electric treatment, and adopted electro-negative puncture through the posterior vaginal wall as the only method available. At this sitting I was enabled to pass a current of 150 milliampères without great discomfort. The treatment was repeated on the 21st; and on the 23d the patient informed me that since the last application she had been entirely free from pain, an experience she had not had for months, and, further, that she could retain her urine while in the recumbent position. The applications were continued at weekly intervals, and after the seventh application, on the 26th of January, she had absolute control over her bladder in any position. Applications were continued twice weekly until twenty had been given, and as the hemorrhage had now considerably abated, and the pain absolutely ceased, treatment was discontinued on the 19th of March. Unfortunately, late in July, feeling particularly well, she resumed her corsets and went for a long walk, with the result that the old pressure pains and urinary symptoms returned, associated with severe vomiting and an increase in the albuminuria. The electric treatment was again continued with the same satisfactory result as regards symptoms, and after the tenth application I was astonished to find that the tumor had entirely passed into the abdominal cavity, and the cervix could be reached with ease. Intra-uterine positive electricity was now commenced, and a further ten applications given, treatment being altogether suspended on the 10th of October, 1895. Since that time she has been in absolute health, menstruating regularly, for about five days; and, on examination, the tumor can now be felt freely movable in the abdomen, and springing from the fundus uteri, its upper border reaching about two fingers' breadth above the umbilicus (Fig. 64). It would thus appear that the

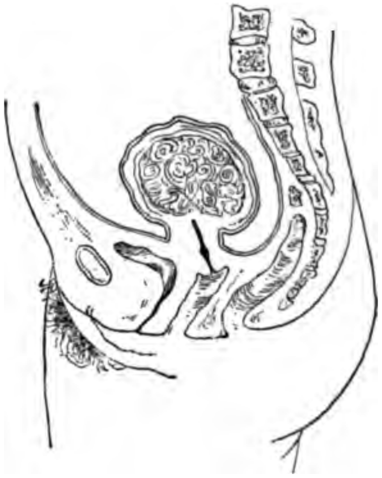


Fig. 64.—Case 1 After Treatment. (*Haultain.*)

tumor was essentially of the subperitoneal type, and had become accidentally incarcerated in the pelvis, where it had continued to grow, but, after having become diminished in bulk, it had returned to the abdominal cavity.

Case 2.—Miss S., aged 38, consulted me in February, 1893, on account of a large fibroid tumor which, for a week previously, had caused complete retention of urine, and necessitated the regular use of the catheter. For some weeks before this time she had suffered from occasional transient attacks of urinary retention, which occurred about her menstrual period. She had already consulted an eminent specialist, who stated that nothing short of complete removal of the growth would benefit her; but, having heard from a friend about the electric treatment of tumors, she decided to try if, by this means, anything could be done for her, before, as she graphically put it, she allowed herself to be "cut up."

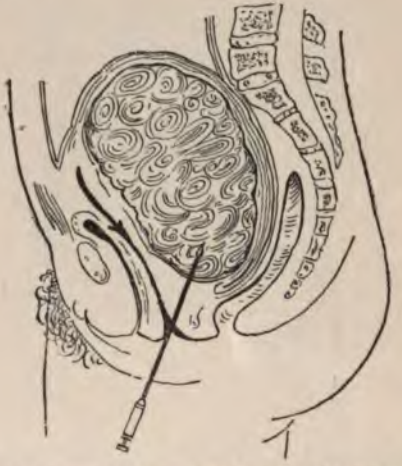


Fig. 65.—Outline of Tumor in Case 2 of Dr. Haultain's Before Treatment. (*Haultain.*)

Beyond the urinary retention and its associated discomfort, she did not complain of any other well-marked pressure symptoms. She was stout and plethoric in appearance, and, further than suffering from a dull and almost constant headache, and a feeling of weight and fullness from the presence of the tumor, she felt strong and well. She menstruated regularly, but scantily, for about two days. On examination, a large, solid swelling could be felt in the abdomen, reaching to two fingers' breadth above the umbilicus, continuous with a large, solid mass within the pelvis, which so obstructed the vaginal examination that the cervix could not be reached (see diagram, Fig. 65). Energetic attempts to push the pelvic portion of the tumor above the pelvic brim proved absolutely futile, though made with the patient anesthetized and placed in the prone and genu-pectoral positions.

Treatment by electro-negative puncture was commenced on the 24th of March, a strength of current of 180 milliampères being used, with the astonishing result that spontaneous micturition could be accomplished the same afternoon, and from that day to this a catheter has never been again required. The first menstrual period was extremely profuse, and lasted ten days. Subsequently, fifteen electro-punctures were made within the next ten weeks, and by the middle of May the growth had so materially lessened in size that I could with difficulty reach the cervix, and was able to introduce the electrode within the uterus. The cavity measured four and three-fourths inches. I then continued the treatment by giving a further fifteen applications with one electrode in this situation. I, however, maintained the intra-uterine pole negative, as, from the increased menstrual periods her headaches had ceased, and I feared that the positive pole might here cause a diminution in the amount, which would be injurious.

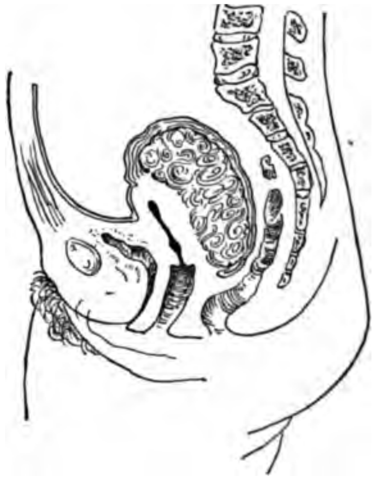


Fig. 66.—Case 2 After Treatment. (*Haultain.*)

After the completion of the treatment the patient returned to her home in London, and I did not see her again till six weeks ago. On examination then I found the tumor still pelvic, situated on the posterior uterine wall, and about the size of a small cocoanut, the uterus and the tumor being freely movable together. The cervix was easily reached, and the sound passed into the uterine cavity about three and a half inches: one and one-fourth inches less than when first measured. The patient described herself as being in perfect health, and her menstruation perfectly regular, but much increased in amount. The tumor in this instance was evidently intraligamentary, as, though free from incarceration, it still retained its position within the pelvis.

Case 3.—Mrs. B., aged 46, was recommended to me by Dr. Macdonald Robertson in May last. She suffered from complete urinary retention, which had continued for three days. She had had previous transient attacks of similar nature. Menstruation regular and normal.

On examination, a large tumor was found impacted in the pelvic brim, tilting the uterus high above the symphysis pubis. Attempts at reposition into the abdomen were futile. Electro-negative puncture was adopted, with the effect that the same afternoon she was able, with difficulty, spontaneously to void urine. Retention, however, recurred the following day, and persisted till the next application of the battery, when again the urine could be temporarily voided voluntarily. After the third application retention did not recur; after this, two applications were made, but the patient, being extremely nervous, refused further treatment. Since that time I have not again seen her, but hear from Dr. Robertson that he has not again been troubled to pass the catheter, and she says she feels quite well.

On carefully reviewing the salient features of the result of the electric treatment of the cases I have just described, the outstanding benefit derived in one and all is the rapid removal of the pressure symptoms. This, in the last two, was so immediate in its occurrence as to be difficult to credit; while in the first case, though somewhat slower in its development, it was equally striking. That this result is due to actual shrinkage in the size of the tumor there can be no reasonable doubt. Though inappreciable at first to the examining fingers, the subsequent course of Cases 1 and 2, as well as the want of other reasonable explanation, fully justifies this assumption.

In Cases 2 and 3 symptoms of pressure had only been experienced for a few days, and therefore any great diminution in the size of the tumor was probably unnecessary to relieve the urgent conditions present, and can be accounted for by contraction of the capsule. In Case 1, on the other hand, severe pressure symptoms had been present for months, and were becoming aggravated from the continued growth of the tumor, and thus a considerable diminution in the size of the growth was necessary before they could be removed. That this shrinkage in the size of the tumor was permanent, and not merely a temporary benefit of the treatment (as is averred by many to be the only value of electric treatment), there is no gainsaying. In Cases 1 and 2 no treatment has been adopted for more than eighteen months, yet, not only have the symptoms of pressure entirely subsided, but marked diminution in the size of the tumor is palpable. The sudden recurrence of pressure symptoms in Case 1 is easily to be accounted for by the corsets pushing the tumor deeper into the pelvis.

Perhaps the outstanding feature in the effect of the electric treatment in Case 1 is its success after the removal of the uterine appendages had failed. It would appear, from the writings of some eminent gynecic surgeons, that many cases previously treated by electricity subsequently find their way to them to be cured. Fortunately, such a necessity has in my experience been quite the exception. In fact, I cannot recall a single instance in my knowledge On the other hand, it is but rarely that the electrician seems to have had as yet the opportunity of stepping in where they have failed. The case I have cited is, as far as I am aware, the only one published in which electricity had been adopted after surgery has failed, with the exception of a failure of Thornton's,[1] in which he sarcastically attributes his want of success to the patient falling into the hands of the electricians. How the electricians fared he does not venture to state.

In Case 2 a somewhat striking result was the increase of the menstrual flow, attended by an entire disappearance of the continuous headache from which the patient complained. This might be deemed probably of the nature of an accidental coincidence, were it not that I have observed the same results in other patients. It would appear that some exceptional cases of fibromata, even though associated with an enlarged uterine cavity, instead of increasing the menstrual flow, are actually associated with an abnormal diminution in its amount, which results in the attendant discomforts of plethora, as commonly met with at the menopause. How the electric treatment effects an increase in the flow it is difficult to conjecture; perhaps it may be by stimulating ovarian activity; but the fact remains that I have several times met with this curious phenomenon, which has been attended by most beneficial constitutional results. Doubtless ignorance of the mode of action is unsatisfactory; and it is perhaps this want of knowledge which has influenced many in giving electricity so wide a birth, and not a few to condemn it wholesale. But satisfactory results are all-important, and, so far as I personally am concerned, suffice to stimulate me to work contentedly in darkness, as probably by this means alone will any rays of light be attained.

A further point of very considerable practical bearing is that, in Case 1, after thirty puncture applications, the tumor rose out of the pelvis into the abdominal cavity. It thus shows that if judicious puncture methods are employed there need be no fixing of the growth by dense adhesions to surrounding structures; and thus the argument used by certain writers, that electric treatment seriously increases the difficulties of future operation by causing dense adhesions, must, so far as this case proves, be absolutely groundless. Certainly where the old, crude methods of puncture were employed such a result was almost a necessity; but, with the insertion of the exposed portion of the electrode well within the tumor, as now employed, this complication is efficiently avoided.[2]

The practical results obtained from the treatment of the above cases by electro-puncture, I think, thoroughly justify its adoption. Doubtless but three cases are too few from which to form definite conclusions; but cases necessitating the employment of puncture methods are fortunately rare, and where the intra-uterine method can be undertaken it should always be adopted, the results being equally satisfactory, less irksome to carry out, and associated with probably less risk to the patient. As I have already stated, the cases cited represent my entire personal experience in the electro-puncture methods, or, in other words, were all that I have seen (among over eighty cases in which I have adopted electric treatment) in which I have been unable to insert the electrode into the uterine cavity.

---

[1] Playfair and Allbutt, "System of Gynecology," page 629.

[2] Dr. Haultain explains, in an unquoted portion of the paper, that he employs buried puncture, the details being similar to those given in the present work and probably first suggested by me in the first edition of "Electricity in the Diseases of Women," in 1889.

If such beneficial effects are to be got from a conservative method in the treatment of fibromyomata, it is, indeed, surprising how little its adoption is advocated, not to say how heartily it is abused.

May be this is due to medical "electricity" forming the trademark of so many advertising quacks, which thus shock the modest conservatism of the high-toned, professional mind; may be, on the other hand, it is the prolonged irksome nature of the treatment which prevents its adoption by the busy gynecologist; or, perhaps, its methods are too simple and commonplace to induce the laparotomist to leave the beaten track of the linea alba, on which he is ever trying to establish world-records of statistical successes. But, whatever the cause may be, I think there can be little doubt, from a conservative point of view, that the electric treatment of fibroids has not as yet had bestowed upon it the consideration which its results warrant.

It has its failures; but what methods have none? It has, however, no mortality (this I state from personal experience and observation), and here, undoubtedly, rests the main argument in favor of its adoption before other heroic measures are attempted.

Removal of the appendages has, in the hands of the average operator, a mortality of 8 per cent., and in a further 10 per cent. fails in any way to benefit the patient. According to Croom, 20 per cent. of women continue to menstruate after this operation. Further, in a considerable proportion of cases in which this operation has been begun it is unable to be completed.

Hysterectomy, in the hands of the most able and finished operators, has a mortality of 10 per cent., and an average mortality of quite three times that amount.

Surely, then, if electricity as a conservative measure has any beneficial results whatever (and I can personally vouch for a permanent removal of symptoms for over two years of over 70 per cent. of cases), it cannot be altogether rejected and refused a legitimate trial.

The two main conclusions which may be arrived at from the cases quoted seem to me to be:—

1. That electricity has a decided curative action in some cases of fibromyomata, when nothing else short of severe surgical measures can be recommended.

2. That from the absence of mortality in its employment, and also in that it in no way increases the danger of subsequent operation, electricity should, in a large proportion of cases of fibromyomata, be employed before recourse be had to radical surgical interference.

I do not wish to be sentimental, but I appeal to human inclinations. In a case of one who is near and dear, who suffers from chronic invalidism as the result of a uterine fibromyoma, I ask whether many of us would subject her to an 8 per cent. risk of life, with a further 15 per cent. risk of failure by removal of the ovaries, or the terrible mutilation of hysterectomy, before at least trying all conservative means at our disposal. Personally, I unhesitatingly say I would decline, and thus would give electricity, as the most efficient conservative treatment, an honest trial. No harm is done, no valuable time is lost, for in the majority of instances fibromyomata do not call for immediate interference. If it do fail—which in my experience is the exception—we can then proceed with an easy conscience to other more radical and drastic measures. Why ovaries and uteri should be treated with less courtesy than other important organs (not to mention the teeth, which have bestowed on them in many instances infinitely more care and trouble to conserve them) is an enigma difficult to explain. Perhaps woman is herself to blame, the tendency of the age being to minimize the importance of these reproductive functions, of which her matronly ancestors were so proud.

If such be so, it is little credit to the medical profession to foster the idea by condemning these organs, for but minor offenses, to capital punishment without any option.

Dr. Lackie, in the discussion of Dr. Haultain's paper, said that he had had an opportunity of watching one of the cases which Dr. Haultain had recorded. The patient at one time seemed to him to be dying from pressure symptoms and exhaustion, but the effect of the electric treatment which Dr. Haultain carried out was such that now she seemed perfectly well. Hysterectomy was out of the question, as the patient almost certainly could not have borne the shock of the operation; and as it was impossible to reach the interior of the uterus on account of its displacement, he did not know any other means that would have reduced the tumor and so saved the life of the patient. Dr. Lackie had recently observed in another case the effect of electricity in causing contraction of the uterus. Under this treatment a bleeding sessile fibroid had rapidly become polypoidal, and been easily removed, with great relief of symptoms.

CHAPTER XIII.

BENIGN TUMORS OF THE BREAST.

Areolar Hyperplasia of the Mammary Gland.—The mammary organs of women are subject to inflammatory indurations and adenomatous growths that simulate malignant tumors and often cause grave anxiety. A presumptive diagnosis of benignity is, however, often possible by a careful consideration of the symptoms, among those favorable to benignity being the youth of the patient, distinct evidences of inflammatory reaction, tenderness, slow growth, and nonadherence to the overlying skin. What might be termed a chronic lobular mastitis is probably the most painful form of tumor of the breast, presenting a nodule from the size of a hazelnut to that of a considerable portion of the gland, which is tender to the touch and the seat of a constant ache. Such tumors are most frequently found in young women, both married and single, and are often in close sympathetic relation with disordered menstruation or even ovarian congestion. They are, of course, not true tumors in the pathologic sense of the term.

Skene, in a work which deserves to be regarded as a pioneer treatise on the science of medical gynecology as contrasted with the merely surgical treatises that have preceded it, describes this condition under the name of "areolar hyperplasia of the mammary glands."[1] With the exception of the first case, in which the breast was removed, some twenty-three instances had been observed by him, and all recovered under medical treatment without resort to surgery. How many of these cases would have preserved their breasts in less conservative hands? In all such cases the suspicion of malignancy, either present or prospective, would have been sufficient to warrant ablation at the hands of surgical enthusiasts, and an inflation of the statistics of nonrecurrent malignancy would have surely resulted.

When in doubt as to the true nature of these lobular hardenings of the breast the application of the induced current to the swelling will clear up the diagnosis, and, if the induration is not malignant, will cause a resolution of the hardened region in from three to six weeks. If the case is malignant no change will occur.

---

[1] "Medical Gynecology: a Treatise on the Diseases of Women from the Standpoint of the Physician," by A. J. C. Skene, M.D., page 355.

This valuable diagnostic and therapeutic use of the induced current was unknown to the writer at the date of the previous edition of this work, the rule then followed being the application of the constant current alone for the resolution of sluggish inflammatory swellings. Experience with the following cases has caused a change in this view:—

Mrs. W. P. W., aged 51, applied for treatment of a lump in the breast in May, 1900. Both a maternal and a paternal aunt died of cancer, and two nieces have the disease at present. The lump in her own breast, has, however, disappeared three times in the last four years under the induction current applied by Dr. J. H. Yeagley, of York, Pa., who sent her to the author.

The method, having been so successful in former indurations, was applied again, a large indifferent pad being beneath the back, connected with the negative pole, the active pole being a cotton and gauze pad slightly larger than the induration, covered with a pliant plate of block tin, conformed to the surface. About a month's treatment, triweekly, caused the lump to disappear entirely.

On two subsequent occasions the indurations reappeared, at intervals of about a year, disappearing on the second occasion in two weeks and on the third after a single application of half an hour's duration. These lumps were somewhat painful.

Miss G., aged 43, applied for treatment recently with several painful indurations in both breasts. The induction current was begun for diagnostic and possibly therapeutic purposes, a similar electrode being applied to the largest induration in each breast. The two breasts were thus treated by different induction current poles, notwithstanding which an equal recession has been noted. The patient is still under treatment.

Cystic Disease of the Mammary Gland.—This affection, which is often multiple, has been said to degenerate into cancer at times. If the cyst is deep-seated the diagnosis may remain doubtful, as in the second case related below, until the characteristic yellowish serum is removed by aspiration.

The most thorough and satisfactory method of treatment consists of aspiration, injection of the cavity with liquid mercury through a gold needle (Fig. 71), which is left in place for cataphoric sterilization, preferably under ether. This eradicates the secreting membrane at once, destroying any possibly malignant cells at the same time. The following cases illustrate the technique:—

A lady of slight physique, aged 39, was referred to me by Dr. I. E. Richardson in March, 1900, with the following history: Two years before Dr.

Richardson removed the left breast for a supposed carcinoma, which on examination was thought to be a cystic adenocarcinoma. A year and a half later a similar condition appeared in the other breast, and Dr. Richardson ultimately sent the patient to the author for cataphoric treatment.

Two large cysts existed in the upper, inner quadrant of the breast. She was placed under ether, the cysts were opened with a small bistoury and a small gold tubular electrode inserted in each cyst in turn, through which the dark-brown fluid escaped. The cysts were then filled with mercury through the instrument, and as they were large, 400 to 500 milliampères was turned on for eight and sixteen minutes, respectively. The cavities were then left to close spontaneously, the edge of the openings being thoroughly cauterized with the noninsulated, mercury-covered electrode. Complete obliteration of both cysts resulted after a somewhat tedious period of drainage, and no return has appeared at the end of three years.

A lady of 41 years, a resident of Pittsburgh, Pa., applied for treatment February 27, 1902, fully convinced that she had a cancer in the left breast. Several surgeons had assured her that they could find nothing abnormal in the breast, without convincing her.

After a prolonged examination, assisted by the patient leaning forward in a position that allowed the breast to fall forward, it was thought that fluctuation could be detected in a small area near the nipple. Preparations were accordingly made for a major application of gold-mercury cataphoresis.

As the patient insisted that no cutting instrument should be used, an ordinary aspirator needle was attached to a small wire to act as a negative pole, the insertion to be made by the action of the current and pressure. With the large indifferent pad employed in massive mercuric cataphoresis beneath the back and attached to the positive wire from the apparatus, the patient was etherized and the needle pressed against the skin just over the supposed cyst. With about 150 milliampères in circuit the needle readily entered the cavity, one ounce of straw-colored fluid immediately flowing out, to our great satisfaction. An amalgamated gold tube of the same size was then inserted into the cyst through the opening made, mercury was injected, the polarity of the active electrode changed to positive, and 200 milliampères turned on and maintained 45 minutes. The mercury was then pressed out and the opening allowed to close spontaneously, complete healing occurring by the end of six weeks. The resulting scar was a mere dimple in the breast some months later.

The patient remains free from recurrence at the end of more than two years.

CHAPTER XIV.

THE TREATMENT OF CANCER BY CATAPHORIC STERILIZATION—THE AUTHOR'S METHOD.

ONE of the most active phases of recent medical history is the aroused interest in the subject of cancer and its curability. The question of the increased prevalence of this group of affections has received much attention, the result of studies of statistics showing a distinct advance in its relative frequency. In a paper published several years ago[1] the author presented a series of charts of the cancer mortality of seven of the largest American cities, showing that in the combined populations of these cities the death-rate from cancer had advanced from 355 per million living persons in 1870 to 665 per million living persons in 1898; in other words, the prevalence of the disease in these cities had almost doubled in twenty-eight years. Many other writers reach similar conclusions.

Another question under investigation relates to the true nature of the cancerous process, which has not yet been absolutely determined, with all the evidences pointing to an extrinsic, parasitic agent, of probably protozoal character, with the power of migrating into and eroding surrounding tissues. While most attempts at grafting cancers from animal to animal or man to man have failed, the individual affected by the growth is extremely susceptible to its reimplantation elsewhere in his body, either by a transmission of grafts that gain entrance into veins or lymphatics by erosion, by means of the blood or lymph currents of these vessels, the grafts accidentally lodging in internal organs; by mere contact of the growth with healthy mucous membrane, as when a cancer arises in the vagina at a spot in contact with a cancer of the cervix, without continuity of the growth; or when an instrument employed to cut or puncture a cancer is passed through healthy tissues without thorough sterilization.

But, probably the most remarkable development of the past five years is the demonstration that the Rœntgen rays have a deterrent action on the progress of superficially situated cancers, leading in some instances to actual cure.

---

[1] American Journal of the Medical Sciences, February, 1900.

Without further reference to the radiotherapy of cancer, in view of the fact that several volumes and many journal articles have been devoted to the subject, the question arises as to the best method of immediate destruction of a parasitic local growth, such as a cancer, when immediate action is desired, or when it is situated within an accessible cavity and yet beyond reach of the x-rays.

Removal of all affected cells and intercellular substances by the knife or by caustics has unquestionably been accomplished in some instances, particularly since the adoption of the modern extensive operations in which all surrounding tissues are removed with the growth; and there can be no question but that a large number of successful results would follow an earlier resort to this form of operation than the usual dread of the knife permits. The history of the ultimate results of cutting operations has, nevertheless, been a gloomy one. The late D. Hayes Agnew, Professor of Surgery in the University of Pennsylvania, whose experience with these cases was very large, made the statement to a friend of the author shortly before his death that he had removed a sufficient number of these growths to fill an ordinary cart, but that all of the patients from whom they were removed had ultimately died of the disease.

The necessity for the removal of every infected or parasitic cell of the mother tumor in order that local or regional recurrence may not follow the removal of the primary growth is one of the chief difficulties of both the knife and caustic methods of treatment. In spite of a thorough removal of many cubic inches of contiguous structures the possibility of missing the distal portions of the delicate prolongations is ever present with either method, and it is in these irregular and often nonapparent streaks of cell proliferation that local recurrences arise. This method of destruction or removal cannot pass beyond the cut or cauterized edge.

Aside from the disadvantage attending a serious loss of blood in the removal by the knife of certain highly vascular malignant growths, the possibility of the cells of the cut growth being regrafted in the cut edges of the healthy flesh has been recently realized by surgeons, a number of instances of this form of recurrence having been distinctly traced.[1] If, indeed, the real *materies morbi* be microscopic entities within or between the cells, as seems practically proven by pathologists, their attempted removal by an operation that opens vast areas of absorbent structures for slow reimplantation of the non-devitalized cells is highly unscientific. Many cutting operations may be followed by beautiful results in immediate union of the apparently healthy surfaces, it is true, but since auto-infection is extremely easy, though slow in showing, it may be that these apparently excellent results only conceal for a time a well-sown crop of fresh germs. If the knife is necessary, its use should be followed immediately by the author's method of sterilization of the cut edges, as described below.

---

[1] Cullen, "Cancer of the Uterus," D. Appleton & Co., New York, 1900, page 658.

The Author's Method.—The need of an agency for the immediate destruction of a cancerous growth and a thorough sterilization of the surrounding tissue has, the author believes, been supplied by a happy accident, which demonstrated, as far back as 1893, that electrolytically produced ions of mercury and zinc may be radiated throughout the growths so effectively that, during the half hour to two hours required for the process under anesthesia, the growth itself is necrosed *en masse*, forming a controllable *area of necrosis*, limited by the after formation of a line of demarcation, while the decreasing density of the cations of mercury and zinc driven beyond the point where they are capable of necrosing yield a sterilizing effect on the outlying prolongations of the cancer cells, the latter being less resistant to the lethal action, producing a surrounding *zone of sterilization* of small extent, but great usefulness.

The result of such an operation in experienced hands should be the immediate death of all the lowly organized malignant cells of a cancer, the dead tissues being thrown off by nature in from seven to twenty-one days, and the devitalized cells in the sterilized area being absorbed as harmless *débris*. The cavity that thus results at the site of the area of necrosis is filled by normal granulations in a few weeks.

The special merits of this method include not only the destruction of the growth proper and the sealing of the afferent vessels from its edges, but the replacement of the senses of the operator by a physical force in the tracing out of the prolongations, which, being better conductors of electricity by reason of their cellular character, invite a greater flow of the chemical-laden current in its transit from the electrode. In addition, it is the purpose of this method to arouse the defeated physiologic resistance of the surrounding tissues into renewed activity, that the normal phagocytosis may be re-enforced.

Corroboration of the results of this method in cancer has been published by Dr. Amédée Granger, of New Orleans,[1] who reports twelve unselected cases treated by him, eight of which were situated in the head or neck, presenting added difficulties due to this situation. The cases were divided into three classes: operable, inoperable, and hopelessly inoperable, with the following results: Operable cases treated, 3; cured, 3. Inoperable cases treated, 6; cured, 2; improved, 2 (1 of these cases is still under treatment with hope of a cure); palliated, 1; failed, 1 (in this case the major application was indicated, but could not be employed). Hopelessly inoperable cases treated, 3; palliated, 1; failed, 1; died, 1. Dr. J. McFadden Gaston, of Atlanta, treated a case of inoperable sarcoma of the abdominal wall as far back as 1897 by a method somewhat similar, though independently developed. This case was reported in full in the preceding edition of this work, and Dr. Gaston has recently informed the author that the patient remains well.

The effective agents in this method of cancer destruction and tissue sterilization are, of course, the nascent chemicals, the electricity being simply an agency for forcing the chemicals into the desired portion of tissues and into chemical union with them. Electricity itself has been used by a number of electro-therapeutists in this country and abroad,[2] and notably by Dr. Inglis-Parsons, of London, whose method may be found described in "The International System of Electro-Therapeutics" and in a special *brochure.*[3]

The laws of electro-chemistry involved in the cataphoric diffusion of mercury and zinc ions are fully discussed in the sections on electrolysis and cataphoresis in Chapter IV, page 45.

As to the physical results accomplished by the method, one needs but to observe a single application of a current over 350 milliampères to be convinced of their effectiveness in an appropriate case. When as much as 1600 milliampères are employed, as has been done more than once by the author, the immense power of this force becomes evident.

---

[1] New Orleans Medical and Surgical Journal, December, 1903; also Journal of Advanced Therapeutics, October, 1904.

[2] For an excellent bibliographic review of the treatment of cancer by electricity in the past see an article by Mrs. Edith Faithfull in the Contemporary Magazine (English) for March, 1892, the writer stating that, having been placed under this treatment after failure of the knife, she had searched out the literature of the subject. She has gathered a remarkable number of references to its successful use.

[3] "The Healing of Rodent Cancer by Electricity," by J. Inglis-Parsons. London, 1893: John Bale & Sons.

The diagram, Fig. 67, illustrates the formation of the area of necrosis and the zone of sterilization, as produced on a surface growth.

During the passage of the current the diffusing ions cause a grayish-white necrosis to spread from the active electrode or electrodes, at a rate dependent on the strength of the current, the tumor substance becoming soft as it is invaded by the chemicals, this softening being the important index of completeness of application when the tumor is not directly in sight.

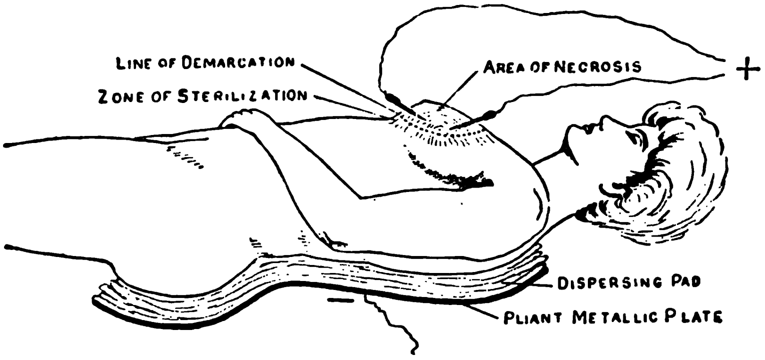


Fig. 67.—Cataphoric Destruction and Sterilization of Cancer of the Breast. Illustration of major method, and resulting area of necrosis and zone of sterilization.

THE MAJOR APPLICATION.

Source of Current.—*Direct Current Mains.*—Where incandescent mains furnishing 110 volts of direct current are at hand this source of current is most convenient and least expensive. With the very large dispersing pad always used reducing the resistance of the patient to a minimum, 800 to 1000 milliampères may be developed from this source, though most of the author's major applications have been made at patient's homes and other points where this current was not available, battery currents of from 80 to 160 volts being employed instead.

To utilize this current for this purpose we need only a proper controller and meter, and the necessary double cord connection with plug attached, the plug being of the variety specially suited to the lamp receptacle from which the current is to be obtained. The controller must be the author's heavy-current graphite controller shown in Fig. 111, as the smaller graphite controllers are liable to be injured by heating when more than 300 milliampères are passed through them.

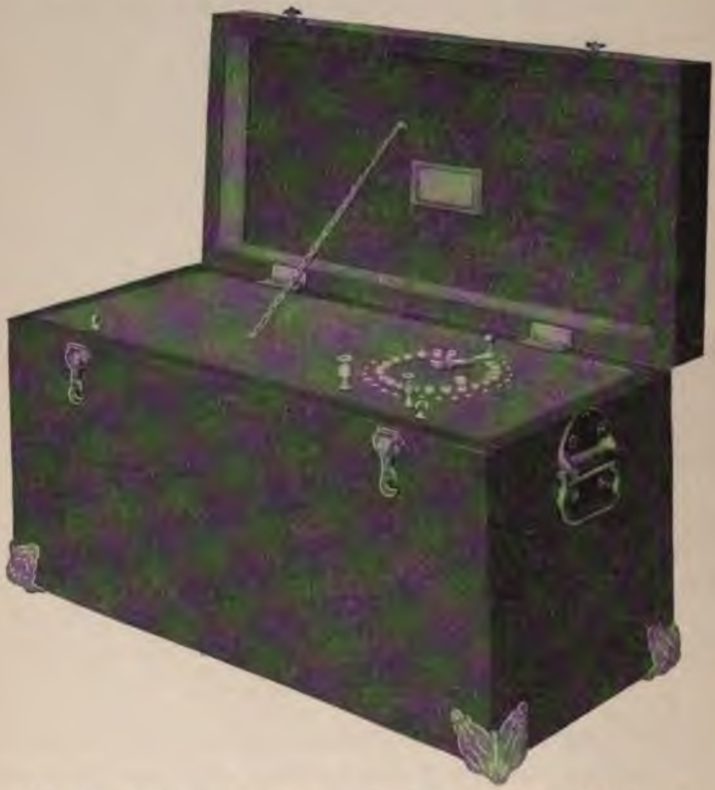


Fig. 68.—Author's Portable Dry-Cell Battery with Lid Raised, showing Switchboard.

In connecting this apparatus for the operation the plug is placed in the receptacle, and the free ends of the double cord (which are handled carefully when the plug is placed in the socket, to avoid short-circuiting and destruction of fuse) are placed in a glass of acidulated water or saline solution and the wire giving off the greatest bulk of gas is identified as the negative pole. This is at once attached to the

N binding post of the controller, the other wire being securely attached to the *P* binding post of the same piece of apparatus. A stout piece of copper wire is now carried from *N.N.* post of the controller to the metal plate under the dispersing pad, and another wire is carried from the *P.P.* post of the controller to the + post of the meter.

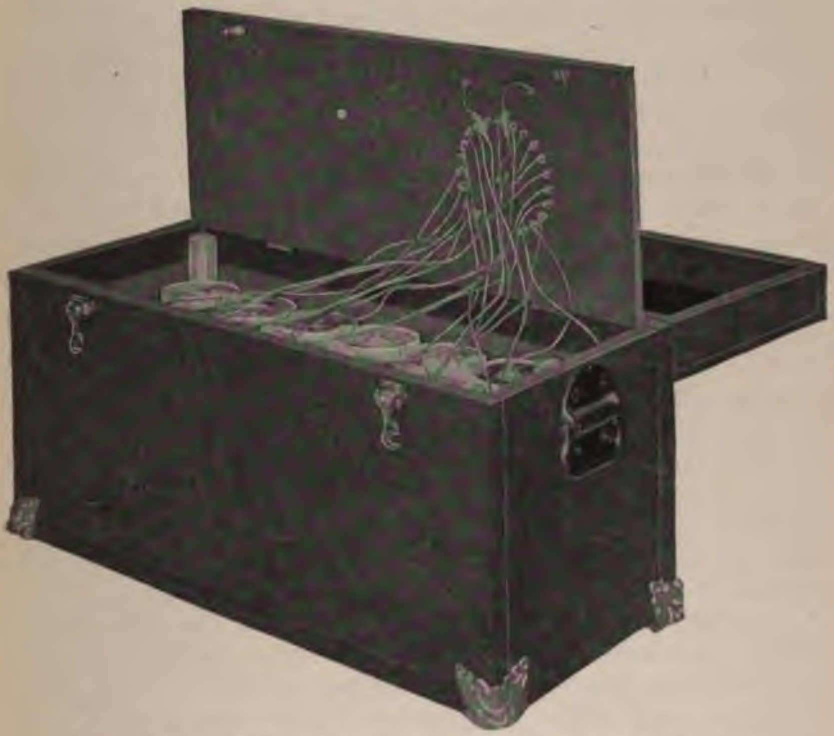


Fig. 69.—Portable Battery with Switchboard Raised, Showing Large Columbia Dry Cells.

The apparatus is now ready for work, and should be tested by attaching a temporary wire to the other, or treatment, post of the meter and touching the metal plate with its other end, while the current is turned on at the controller. The circuit being found to be complete, the temporary wire is detached, the controller crank turned back to the starting point, and all binding posts examined to see if they tightly grasp the wires.

Battery Current.—When the current mains are inaccessible, or when a greater voltage than 110 is required, we must have recourse to battery currents, which may be from a suitable number of storage cells in a hospital. The weight of the requisite number of these cells (from 50 to 80) of course makes their use in a portable form impossible. Of the primary cells we can only use a type capable of yielding 2 ampères for an hour or more, and though most of the author's applications have been made with three specially constructed acid batteries now laid aside, he has recently demonstrated the possibility of employing the largest size of Columbia dry cells in this work, 40 of these cells, each measuring 8 by 3 $^1/_2$ inches, having maintained a current of 1600 milliampères for an hour and twenty-six minutes with the patient in circuit, with a temporary fall of but five volts, four of the lost volts being regained a week later. From this showing of their capabilities it is evident that this extremely convenient form of battery will be capable of a considerable number of such applications without demanding any care whatever, presenting a most marked contrast with the troublesome acid cells. If the set of cells employed in this case will remain strong enough, assisted by ten others, to produce current enough for five more such strong applications, the cost of new dry cells, though considerable, will not equal the cost of renewal of zincs and battery fluid for six such applications; for it is necessary to have perfectly fresh battery fluid for each operation with the acid cells, and after every third operation new zincs must be supplied for all three of the acid batteries required.[1]

In the experiment referred to the author took the precaution to provide one hundred of the dry cells to make sure of sufficient current being available after the patient had been etherized, and to make assurance doubly sure, a complete and freshly charged set of acid batteries was at hand. These precautions were far more than necessary, as proven when the current was turned on, for the resistance of the patient having been brought down to a low point by covering most of the trunk with dispersing pads backed by pliant sheets of thin block tin, it was found that forty cells would maintain all the current necessary for the destruction of the large sarcoma of the perirectal tissues under treatment. Double this number, or eighty cells, have since been usually employed to make the action on the cells more uniform, when governed by the controller.

---

[1] Since the above was written 80 of the set of large Columbia dry cells alluded to have been used in twenty operations, the strength of the current varying from 350 to 1700 milliampères each, for various durations, and are still ready for work. The total voltage of the set has fallen from the original 120 to 110, having lost but 10 volts.

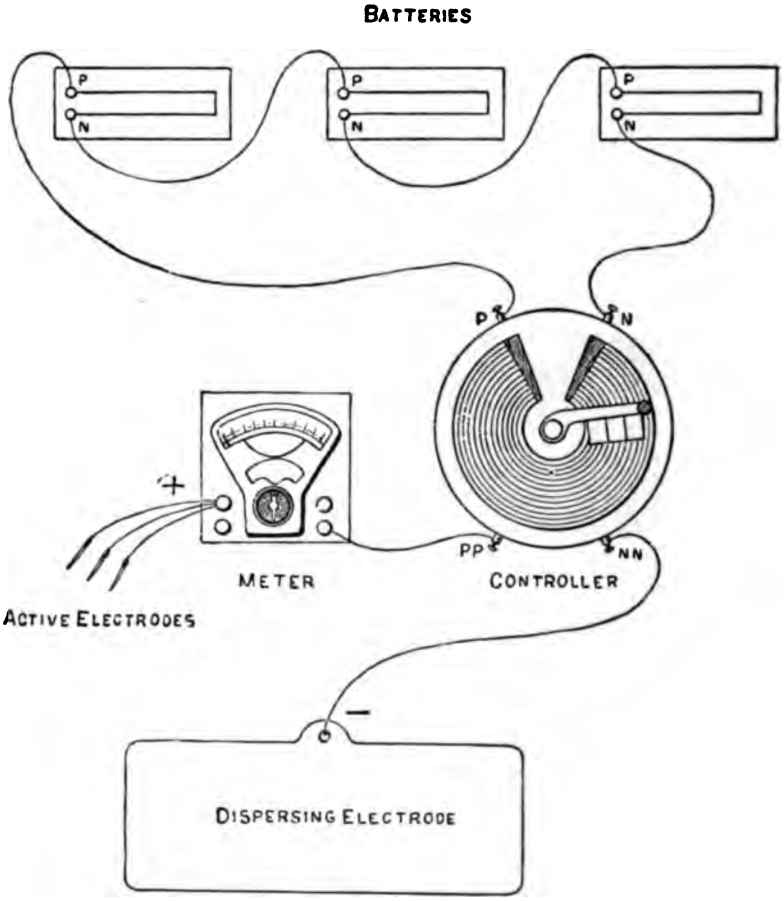


Fig. 70.—Arrangement of Batteries and Apparatus for Major Application of Cataphoresis.

As before stated, portability of the battery is quite essential in this work, which is as well done at the patient's residence as in a hospital, and the author has taken the acid battery set thousands of miles, in trains and other conveyances. The dry cells recommended, the largest size of Columbia dry cells, are much heavier than acid cells. It was therefore necessary to install only twenty in each box, the one hundred employed in the experiment being placed in five battery boxes, each box requiring two men to handle it.

One of the battery units employed is shown in Figs. 68 and 69 and was made for me by Otto Flemming, of Philadelphia. It consists of a stout box capable of holding the twenty cells snugly. Over the cells is an inner lid hinged at the back and fitted with a twenty-point cell selector, which puts each cell into circuit as the switch is turned, and two binding posts. When resting at *O* this switch should make an all-metal circuit between the binding posts so that all the units can be put into the circuit with switches resting on the zero buttons and any number of units be turned on without breaking the circuit. This inner lid, or switchboard, can be raised at any time for examination of the cells. Over the inner lid an ordinary outside lid is provided for closing the battery when not in use.

From three to five of these units (containing from 60 to 100 cells) are connected together for the application as shown in Fig. 70, the positive post of the first being connected with the *P* pole of the controller and the negative post with the positive post of the next unit, and so on, the final negative post of the last unit being connected with the *N* post of the controller.

The author feels assured that these large dry cells will solve the difficulties and discomforts attending the employment of massive cataphoresis at the patient's residence, and should do much to popularize the method.

Controlling Apparatus.—*The Controller.*—The only possible way to control the current of the mains smoothly and without shock for cancer operations is by the use of the universal therapeutic controller recently designed by the author and described on pages 331 *et seq.*, Fig. 111. This instrument permits of a perfectly smooth control of the current from a fraction of a milliampère to 1700 milliampères, or more. For ease of portability it should be placed in a box specially designed for its carriage.

When using the dry cell equipment described above the controller is not absolutely essential, for a smoothly acting cell-to-cell selector adds but $1\,{}^1/_2$ volts at each button, which produces so little irregularity as to be negligible in currents of this magnitude. The large controller described is, however, useful even with the cells, as it enables the strain of service to be distributed over a larger number.

Meter. — The author employs also a special Weston meter for cancer work, graduated from 0 to 1000 milliampères on the lower scale, and from 0 to 2000 milliampères on the upper scale.

To use this meter the positive wire is attached to the + binding post as usual, the leading-out wire (in practice, the wires attached to the active electrodes) being attached to either the post marked 1000 or that marked 2000, as we wish to employ below or above 1000 milliampères, care being observed to turn the pointer on the right of the instrument to the scale in use. The change from one scale to the other may be made after the application has been begun, *but only after the current has been turned off,* as otherwise a break is made in the circuit.

Dispersing Electrode.—An essential feature in transmitting large currents for the major application through the body is the elimination of polar action at the indifferent, negative, contact with the skin. This elimination of polar action is mainly accomplished by making the contact as broad as possible (which gives also the desired effect of lessening the resistance at this point), which, though the total chemic action is the same as before, disperses it over so great a surface as to result in a mere hyperemia of the skin if the dispersing area is large enough and the current evenly spread over it. The second element in minimizing the action of the discharged cations at this contact is the having of a body of liquid between the plate and the skin of a chemic constitution similar to the body fluids and thick enough to absorb a great part of the action of the nascent ions as they reach the plate. Normal salt solution should fulfill this indication very well, the main difficulty being to have the surface broad enough and the thickness of this watery layer so uniform as to prevent a concentration of the current at any spot, making an alkaline necrosis of the skin at this spot.

The continued appearance of burns of the skin beneath the negative pad, no matter how large, and with or without normal salt solution, has, however, caused the author finally to abandon any form of dispersing electrode with these large currents except the Apostoli clay pad, which is specially enlarged for this purpose. These clay pads are kept in shape by being inclosed in white duck, a bag being made of this material about 14 by 20 inches in size, and the clay is put within it while in the state of a dry powder, to a thickness of a little over an inch. While the material is still dry the opening in one end through which the clay has been inserted is sewed up, and the thickness of the clay kept uniform by stitching or quilting the upper and lower coverings of the pad together lightly. The pad is now ready for use when thoroughly wetted, but must be kept wet in a covered vessel, capable of being gently heated, in order to keep it ready for immediate use. Powdered kaolin is an excellent substitute for potters' or sculptors' clay, as it is perfectly white, leaving no stains on the clothing. A second pad is often useful when very heavy currents are used.

The treatment couch, with the dispersing pad, is arranged as follows:—

When possible it is always best to have the patient lie on the dispersing pad, for the back presents the best surface for this action, and the weight of the body keeps the pad in good contact at all points if the latter is well adjusted. A spring cot forms the best operating table on account of its conforming the pad readily to the dermic surface, but an operating table may be so padded with blankets as to serve equally well. On the cot or padded table a waterproof cloth should be spread, completely covering it. On the waterproof is laid a thin lead plate (readily obtained of plumbers' supply houses) or a block tin plate of No. 32 thickness,[1] somewhat smaller than the clay pad, or about 15 by 7 inches, with a binding post affixed to one side, to which is attached the wire leading to the *N.N.* pole of the controller, or a flatter attachment of this wire to the thin metal may be secured by employing a metal catch, such as used as an adjunct to certain suspenders. Over this point of attachment of the wire to the plate a small piece of nonconducting cloth must invariably be placed to prevent short-circuiting of the current to the patient in this situation.

On the plate, so disposed and connected, the warm, moist pad is placed, care being observed that the clay pad covers the edges of the metal plate, and the pad is ready for the patient, who may recline on it before receiving the ether, or be placed on it after anesthesia is nearly complete. A second pad, similarly composed, may be placed beneath the thighs, good contact being secured by pressing the clay against the skin surface.

---

[1] An excellent material for this purpose is No. 32 Crookes metal, obtainable from the Crookes Metal Company, New York City.

Active Electrodes.—In the development of the cataphoric treatment of cancer the author was accidentally led to employ zinc coated with mercury as the material for the soluble electrodes. It was later found that pure mercury could be diffused as an ion from electrodes of gold, the mercury being temporarily united with the gold by amalgamation, and that with heavy currents it would disappear so rapidly from the gold instrument that provision had to be made for an extra supply by injecting it into the tissues after the hollow instrument was inserted into the growth. The gold was never acted upon itself by the current, and when a supply of mercury was completely exhausted, and the alloys in the gold diffused, it remained as an unattackable electrode.

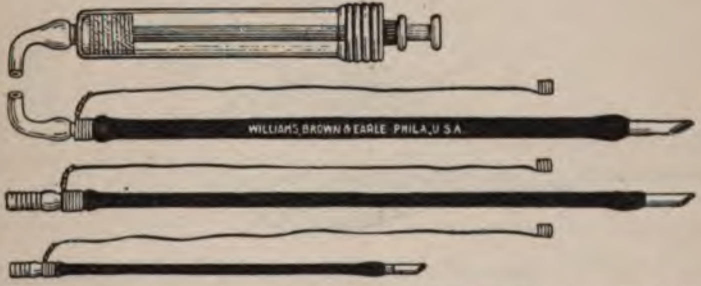


Fig. 71.—Gold Puncture Electrodes with Glass Syringe for Injecting Mercury.

Comparative tests of pure mercuric cataphoresis from these gold electrodes (Fig. 71) and of the mixed zinc-and-mercury cataphoresis from pointed zinc instruments, showed later, nevertheless, that the latter was more effective in necrosing effects and equally as good in sterilization. The pointed zinc instrument merely coated with mercury was also a more controllable instrument than the pointed cannulas of gold, which required to be used with liquid mercury, which could be kept in the place desired only with difficulty at times. The result has been that the zinc-mercury instruments are almost exclusively employed at present, the gold-mercury instruments being mainly reserved for cases where sterilization without extensive destruction is required, as in the treatment of suspicious cysts of the breast where the cyst wall alone is to be destroyed. Fig. 71 shows the pointed gold instruments and Fig. 72 the bulbous gold electrode, which are now not regarded as always necessary in the work.

The zinc-mercury electrodes that have been finally settled upon as the most convenient and effective from every point of view are shown in Fig. 73, and they may be procured in standard sets of twenty-six electrodes from Charles Lentz & Sons, of Philadelphia, and the Frank S. Betz Company, of Chicago. These electrodes embrace all the sizes and shapes necessary in the treatment of growths in any part of the body, though they require to be bent by the physician at times to suit the individual case, and, as zinc is a soft metal, this is readily done. The insulation on these electrodes is black wax, fused on the hot instrument, and this may also require increase or decrease in individual cases as we wish a lesser or greater surface exposed to the action of the current. The mercury is applied to them only when about to operate, as it renders the zinc brittle if kept in long contact with it. Excepting the minor application electrodes, they may be employed more than once, unless special rigidity is desired.

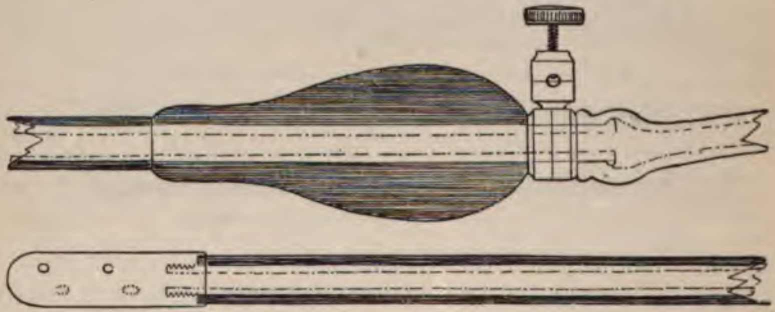
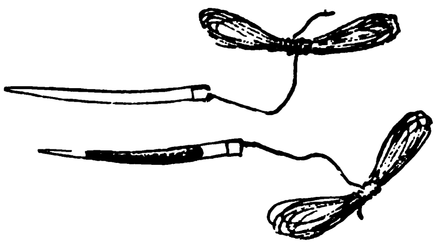


Fig. 72.—Hollow Bulbous Gold Electrode.

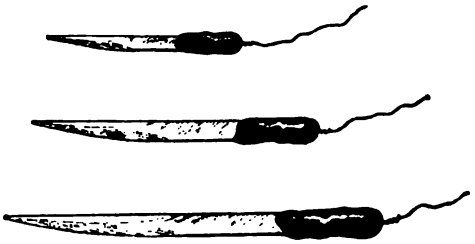
Each of these electrodes, except the throat and uterine types, has a conducting wire attached permanently, special sizes of wire being selected for each instrument to combine a proper conductibility for the current for which they are devised with the least weight, enabling the instrument to be self-sustaining when inserted.

When preparing for an operation the electrodes required should be selected and resterilized by passing them over the flame of a Bunsen burner, this process resulting also in a freshening of the insulation, which should be closely examined to test its completeness.

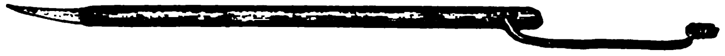
Essential Accessories.—On a tray within reach of the operator should be placed a glass cup containing several ounces of liquid mer-



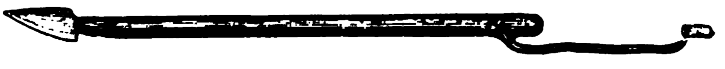
Nos. 1 and 2, minor application electrodes, attached to No. 32 copper conducting wires.



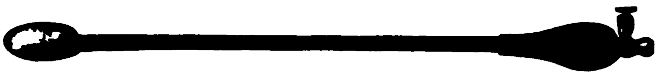
Nos. 1, 2, and 3 breast or external electrodes, attached to Nos. 28 and 26 wires.



Throat electrode for major application, with socket for cord bit.



Pointed uterine and rectal electrode for major application.



Author's tunneled rectal electrode for zinc-mercury cataphoresis.

Fig. 73.—Set of Zinc-Mercury Electrodes for the Cataphoric Treatment of Cancer. These electrodes should be bent to the special curve desired in the particular case and the nonactive parts then insulated with melted sealing-wax over the flame of a Bunsen burner, and should be coated heavily with mercury after shaping and immediately before use.

cury, another cup holding a 10 per cent. solution of sulphuric acid in water, and a third cup containing plain water. There should be also a small bistoury at hand to make openings in the skin for the electrodes if necessary, and some balls of absorbent cotton.

Details of Operation.—Before etherization is begun the batteries should be placed near a table on which the controller and meter are arranged, and connected as shown in Fig. 70. After the connections are made the circuit is tested for current and correct polarity, and the electrodes attached to the proper binding-post of the meter and laid in a tray on a convenient table within reach of the operator.

Assistants.—Besides the anesthetist, the operator will need an assistant to manage the controller exclusively and a nurse to watch the pulse, manage the cooling stream of water, etc., the operator himself being sufficiently employed in managing the electrode and noting the current strength and its effects.

The Application.—The patient having been anesthetized on the couch with its pad in place, and lying on the latter, or placed on the couch after etherization, the indifferent pad should be examined and pressed close to the body, the patient being so disposed as to bring the pad against the lower portion of the trunk mainly, to lessen the amount of current traversing the respiratory muscles. No portion of the metal plate should be allowed to touch the skin.

The active ends of several electrodes are now freely amalgamated with mercury by dipping them into the diluted acid, then into the mercury, and finally rubbing the amalgamated surface on an absorbent cotton wad wet with plain water. An opening is now made in the skin at one side of the growth with a small bistoury, if necessary, through which an electrode is thrust into one side of the growth, or the electrode may be thrust into the growth directly without the bistoury if the surface is covered with mucous membrane, or is softened by the malignant process. In either case the insertion becomes bloodless as soon as the current is turned on. With one electrode inserted the current is gradually turned on at the controller until the desired strength is attained, or, if several electrodes are required, until about 200 milliampères are attained with one instrument in place, when another (with its wire already attached to the treatment binding post of the meter with others to be used) may be inserted and the current increased. This is kept up until enough electrodes and current are in use to insure a thorough employment of the time at our disposal. From time to time an electrode is removed while the others are securely in place, resupplied with mercury, and inserted in a new place. The number of electrodes employed should be governed by the strength of the current in use, not less than 100 milliampères being allowed for each, to secure proper concentration.

Current Strength and Duration of the Application.—The strength of the current and its duration depend entirely on the extent of the growth. The writer's applications under ether have thus far usually varied between 350 and 800 milliampères, though as much as 1600 milliampères have been employed more than once, in all cases turned on gradually without shock or suddenness, and while the effect on the circulation and respiration has been watched if working in the neck or near the heart. In these situations it is turned down temporarily whenever the heart action becomes rapid (which effect is evidently due to the reflexes for pain not being entirely abolished in the earlier stages of the anesthesia).

The time element of the application is most important, for there is a definite speed imparted to the electrons that is not very great, even with a high potential, being usually about a half-inch in each ten minutes. Sufficient time must be taken to soften the whole of the apparent limits of the growth and produce the necessary zone of sterilization, and by moving the electrodes to better points of vantage from time to time this may be accomplished in from one to three hours in a large growth, and in something like a half-hour in a small one.

It should be the aim of the operator to secure complete results at the first application, though a second application can be made some weeks later if this aim has not been accomplished.

Since a powerful current passing near important nerves or nerve-centers governing respiration and circulation may weaken either of these vital actions temporarily to a point dangerous to the patient, the following current strengths may be given as the probable upper limit of safety, judging from the effects noted on pulse and respiration in a number of cases:—

In growths	of the	head, face, and throat	350	to	500	ma.
“	“ “	neck	350	“	400	“
“	“ “	breast, arms, and chest	600	“	800	“
“	“ “	lower trunk and pelvis	1000	“	1600	“
“	“ “	anal and rectal regions	1000	“	1600	“
“	“ “	thighs and legs	1000	“	1600	“

Immediate Results.—Within a few moments after an adequate current has been turned on a whitish-gray color will appear in the tumor in immediate contact with the electrode, which progressively increases in area, radiating in all directions from the electrode. As the area of necrosis becomes greater, and finally includes the whole of the apparent limits of the tumor, it will be noticed that the brawny induration of the growth gives place to a softer and more doughy consistence, corresponding undoubtedly with the loss of tone accompanying the loss of vitality in the malignant cells. This progressive softening of a hard growth is a remarkable phenomenon, particularly when it is remembered that the normal effect of the positive pole is desiccating, and therefore somewhat indurating in soft tissues, and the complete softening of the growth is a most valuable index of a thorough devitalization of the growth, particularly within cavities. Coincident with the change of color and softening, any odor that an ulcerated growth has emitted will be corrected, not to return even during the separation of the slough in most cases. Having decided that the area of necrosis includes the whole growth, with an adequate zone of sterilization, the current is turned off and the patient put to bed.

After-treatment.—The line of demarkation will usually include the decolored tissue only, and after its full development the sterile, inodorous slough will come away, usually in from seven to twenty-one days, the cavity filling with healthy granulations in about six weeks.

The after-treatment is very simple. An aching sensation will last about forty-eight hours, but the patient will cease to have neuralgic pain at once if this symptom were present before the application. During the separation of the slough simple sterile dressings are applied, and after its separation the cavity is dressed with any simple unguent and a gauze pad.

THE MINOR APPLICATION.

The minor application differs from the major application principally in the fact that only such a current strength is employed as can be borne by the patient without general anesthesia. Other points of natural difference are: the use of an ordinary dispersing electrode, such as employed in gynecology, the ordinary voltage of a constant current application, controlled by the regular sized controller and meter. The active electrode (shown in Fig. 73) is almost invariably cut, when required, with long-handled scissors from the thin sheet zinc used by the stove men, and insulated or not as required in the particular application, being fastened to a piece of No. 32 or 30 copper wire as conductor by twisting the bared wire about the shank of the zinc needle thus made and bending the zinc over the wire, thus securing it tightly. The needle is used but once, a fresh one being made for each application. It is, of course, amalgamated with the mercury in the same manner as the larger electrodes.

Another difference between the major and minor application is the fact that the latter is rarely designed to effect immediate and final results, but is repeated daily as long as necessary.

In beginning these applications it may be necessary to make a tiny slit in the skin for the insertion of the instrument, the chloride of ethyl spray being excellent for the painless accomplishment of this maneuver. After the insertion of the electrode a small drop of a strong solution of cocaine should be placed at the point of insertion, the base of the salt being carried inward as a cation, lessening the burning during the application.

The strength of current employed in a minor application may be but 5 or 6 milliampères at first, but after a sinus is made much more current may be employed by insulating the needle with fused wax except at the tip.

It should be remembered, also, that a minor application may be made to the insensitive neck of the uterus, without any kind of anesthesia (cocaine being here of little value), and with a current as great as 250 or even 300 milliampères.

All minor applications should be of thirty minutes' duration to secure effective results.

CHOICE BETWEEN MAJOR AND MINOR APPLICATIONS.

The choice between the major and minor methods in a given case must depend on a delicate judgment on the part of the operator, guided by an experience difficult to formulate. As a rule, all highly malignant or extensive growths, or those situated in sensitive areas, like the lip, breast, and anus, absolutely require the major method. Under the reverse circumstances, including small growths in the mouth or throat, particularly when of slow growth, the minor method may be considered.

In very large growths in the upper portions of the body the risk involved in the use of heavy currents may be greatly lessened by limiting their penetration, and therefore any general action produced by them, by employing the bipolar method described in the following chapter.

CHAPTER XV.

THE CATAPHORIC DESTRUCTION AND STERILIZATION OF MAMMARY AND AXILLARY CANCER.

THE major application of zinc-mercury cataphoresis offers a most effective method for the destructive sterilization of mammary cancer in its early stages, enabling the operator to destroy all infected portions of the gland at once, without risk of the infective cells gaining access to the lymphatic spaces, as may happen in a cutting operation. It enables the operator to confine the destruction safely to the diseased portion alone, should the growth be a small one not involving the whole breast, thus conserving the unaffected portions of the organ. Should the growth be diffuse, with ill-defined edges, the whole of the organ should be included in the area of necrosis at once.

In all cases of mammary cancer a minute examination should be made of the axilla for enlarged glands, and if these are found the area of necrosis should be carried through the intervening tissues to the enlarged gland or glands, using a sufficient number of electrodes simultaneously or seriatim for the purpose, and the application should be prolonged until all apparently infected tissues are included in its necrosed area.

The axilla need not be invaded at this time if no signs of indurated glands be found, but when they are found the complete operation is the only safe course; and the intervening tissues, containing the lymphatic vessels through which the cells have passed and in whose valves some may have lodged, should be invariably included in the area of treatment.

The result of such an operation is as complete as the most modern knife operation, and is almost as quickly done, requiring, as a rule, but an hour to an hour and a half. The sterilizing process may also be carried into the rib interspaces, and even into the rib structures themselves, with far greater ease than is possible when the field is covered with blood, as in the cutting operation. The advantage accruing from the sealing of all absorbents as the process extends, and from the absolutely sterile field left, have been sufficiently indicated in preceding pages.

Technical Details.—The waterproof covered spring cot should be selected for the operation, or a thickly cushioned, full-length operation table, so padded as to keep a large dispersing pad in good contact with the back. When the growth is large as many as six or eight electrodes of the Nos. 1, 2, and 3 external type should have wires of appropriate size attached to them separately, the distal ends of the wires being securely clamped in the one treatment binding post of the meter. They should be laid aside separately in a tray in such manner that the wires will not tangle when they are brought into use. Several of the electrodes may be slightly curved on the flat for greater ease of insertion in a slanting manner.

The patient having been anesthetized, the electrodes are amalgamated freely with mercury and one is passed into the periphery of the growth with the point directed toward the center, a slit being made in the nonaffected skin if necessary. The turning on of the current is then begun at once, and when about 150 milliampères have been attained in the circuit another electrode is inserted in the periphery near the first. As the current is gradually increased additional electrodes are inserted until four or five are acting simultaneously with a current approaching 200 milliampères per electrode, or a total strength of from 600 to 800 milliampères. The electrodes first placed should now be examined closely, and if the necrosed areas about them seem complete one is removed at a time, reamalgamated, and placed in a new position. By this progressive method the whole of the growth and any diseased tissue in the axilla are gradually brought into the area of necrosis, the electrodes being replaced if necessary in any intervening spots left unsoftened. When all hardness has been dispelled, and the coloration shows a sufficient extension of the process, the current is turned off, the electrodes removed, and the patient put to bed.

After-treatment.—The part should be dressed with aseptic gauze covered with absorbent cotton until the slough comes away, the time taken in this process varying from fourteen days to three weeks. In a growth that has not been previously in a condition of ulceration no odor will be noticed during the process of separation, but in those that were highly necrotic it may be wise to apply a powder to the crust composed of powdered zinc oxide, 32 parts; carbolic acid, 1 part; this effectually absorbs the odor until the crust separates by the natural process. After the separation of the slough the wound is dressed with simple ointment on gauze.

No delay ever occurs in prompt granulation and cicatrization, the scar left being often of surprisingly small size.

Selection of Cases and Method.—All forms of carcinoma and sarcoma of the breast are suitable for the cataphoric method, the only condition absolutely preventing success being the presence of metastatic deposits in internal organs. The most favorable cases are, of course, those in which the growth is small and recent. The existence of one or more movable infected glands in the axilla does not greatly complicate a case, for these are readily destroyed, with the intervening tissues, at the time of the destruction of the primary growth.

Another stage of this affection is peculiarly suitable to the cataphoric method, though not so certain in results. This is the late stage of neglected cases, where the ulceration is deep and extensive, rendering any other treatment except the x-rays impossible. Here the whole, or a greater part of the infected tissue is sterilized in either one or two applications (the great extent at times making it impossible to bring the whole of the growth under the method at one operation). The second application is made as soon as healing has occurred after the first—usually about two months later. Whether the x-rays should be then employed if the result is still doubtful remains to be determined.

Such a case as last mentioned often presents so much local purulent mixed infections as to make the cause of the degree of ill health present doubtful. In other words, we may be in doubt whether the anemia represents a true cachexia from internal metastasis, or a mere ill health from absorption of toxins from the local disease. The determination of this point will decide for or against the wisdom of making a major application, for if the cachexia is due to metastasis we should decline to apply cataphoresis, except possibly in a minor form as a palliative. The decision is at times most difficult, and in the interest of the patient we may decide to apply the method with the expressed understanding with the patient's friends that the application itself is the surest way to decide the question; for, if the ill health is due to the toxins of the external growth only, the patient will be in improved health two months later; if due, on the other hand, to metastasis, the patient will not improve after the application, and may even be made weaker by it. This is a most delicate and certain test of the absence or presence of metastasis.

When the disease has invaded the supraclavicular glands the author regards the case as beyond the curative power of cataphoresis, unless but one movable gland can be found, for the deep structures of the neck in this situation make an effective major application most formidable, with risk of secondary hemorrhage at the separation of the slough.

Another unsuitable form of breast cancer for cataphoresis is that known as *cancer en cuirass,* where the infected cells are widely disseminated in the subdermic tissues of the chest, with very uncertain margins. Here the unfavorable elements are the wide extent of the growth and its uncertain edges, besides the great probability of intercurrent metastasis. The author has never seen a case of this nature that had not followed a knife operation, and suggests that it may be due to a widespread implantation of the germs in the severed and patulous ends of the lymphatic spaces beneath the skin. The most neglected cases of breast cancer that have never been operated upon fail to show this peculiar infiltration of the subdermic tissues.

The major application under anesthesia is the only admissible method of cataphorically destroying and sterilizing a breast cancer, mainly because of the sensitiveness of these parts and of the necessity for thorough work. Minor applications should, nevertheless, be made to any suspicious spot within the cicatrix while the parts are healing after a major application, or as a palliative in incurable cases, as the structures are then quite free of sensation unless the skin edges remain infected.

MAJOR APPLICATION OF BIPOLAR CATAPHORESIS.

When the whole breast is infected, or with any large growth in the upper portion of the body, much time can be economized and the duration of the anesthesia lessened by employing the bipolar method, which enables us to use much more current than when the vital portions of the body are included in the path of the current. This method, however, is only applicable when the growth presents considerable tissue between the poles.

In applying this modification of the method the arrangements are made for the ordinary monopolar application described above, for we may wish to use it in the latter portion of the application to carry the zinc and mercury ions deeper, and thus extend the zone of sterilization. Instead of attaching the negative wire to the plate beneath the pad it is attached to a disk electrode, covered with absorbent cotton saturated with liquor potassii arsenitis, and the electrode is placed on the top of the tumor and held in place by an assistant during the operation, while the active electrodes are inserted a little below the base of the growth. As a portion of the current spreads in all directions below the active poles so placed a considerable amount of sterilization of the base can be thus secured, while the 1000 to 1600 milliampères possible in this method quickly destroys the tumor proper.

Illustrative Cases.—*Recurrent Carcinoma of Chest Wall and Axilla after Removal of the Breast.*—Mrs. B., aged 63, applied for treatment November 30, 1897, with a recurrent carcinoma near the site of a scar made by the removal of the right breast for carcinoma. The knife operation had been skillfully performed ten months before by the late Dr. I. E. Richardson, of Philadelphia, the whole of the breast and a portion of the pectoral muscles and overlying skin having been removed *en masse,* and also an infected gland in the axilla. Histologic examination of the removed tumor showed it to be a highly malignant, acinous carcinoma.

Examination on admission showed a confluent mass of nodules, each the size of a filbert, in the subdermic and dermic tissues above the scar, evidently in the line of an infected lymphatic vessel leading to the clavicular glands. The glands, however, showed no sign of having been reached by the diseased cells. At the site of the removed gland in the axilla there was a slight induration. The general health of the patient was so poor as to suggest the possibility of metastasis having already supervened.

On December 11, 1897, with the kind assistance of Drs. Richardson and W. C. Thompson, the patient was etherized and the gold-mercuric method applied by means of three small, gold cannulas in as many centers of growth. The current was gradually brought up to 500 milliampères and maintained at this strength for fifteen minutes. Under this current the nodules quickly softened, and an efficient zone of sterilization was developed. After the recovery from the ether the patient, who was of a highly nervous type, complained of pain for twenty-four hours, doubtless owing to the reaction in the comparatively normal surrounding zone, but the subsequent after-stages were comfortable, and separation of the necrosed material and healing were uneventful. By an oversight the nodule in the axilla was not touched at this time.

In January, 1899, a small nodule the size of a pea, near the clavicle, which had been overlooked, was destroyed in one office application with a zinc-mercury needle, 10 milliampères being employed under the local use of cocaine.

In August of the same year the axillary nodule, having shown increased growth, was subjected to a major gold-mercury application, 200 milliampères being employed for twenty-five minutes. No further applications were required.

The patient, who had been in indifferent health for many years, improved greatly for a time and was said to have looked better than at any time since her youth. Her general health failed in the summer of 1902, and the end came in the latter part of that year, apparently from mediastinal growth. There was no sign of recurrence externally.

Small, Acinous Carcinoma of the Right Breast.—Miss B., aged 51, applied for treatment in November, 1898, with a painless tumor of irregular outline in the lower and outer quadrant of the right breast that was growing rapidly. Dr. Bruce Burns, a well-known surgeon of Frankford, Philadelphia, had pronounced it a carcinoma, and advised immediate removal of the breast.

On November 16, 1898, a gold-mercuric major application was made under ether, with the assistance of Dr. W. Oakley Hermance, a current of from 350 to 475 milliampères being employed with one instrument for forty minutes. The slough produced by the treatment was round, about the size of a silver dollar, and exhibited less solid substance than is usual when the zinc-mercury method is employed, the overlying skin being the chief mass to come away, the diseased tissue being discharged mainly as a lead-colored serum. By the middle of the following January the cavity had healed, and showed no further sign of disease, though several imprisoned globules of unaltered mercury gradually worked their way to the surface with slight discomfort.

The interesting features of this case are the destruction of a small cancer of the breast by one application of cataphoresis without loss of the breast itself, and the linear and insignificant scar that resulted from a considerable loss of tissue. The patient is in improved health at the date of publication.

Acinous Carcinoma of the Left Breast.—Mrs. M. S., aged 57, was referred by Dr. A. F. Muller, of Germantown, in March, 1899.

The whole of the left breast was involved in the growth, which was apparently of the acinous variety, with retraction of the nipple and impending ulceration of the skin. The growth had appeared about eight months before, was rapidly increasing in size, and had begun to give considerable pain. There was no evidence of involvement of either the axillary or clavicular glands, and yet, as subsequent developments proved, she was already suffering from metastasis to the region of the stomach.

Major zinc-mercury cataphoresis was applied March 29, 1899, assisted by Dr. Hermance and in the presence of Dr. Muller. As this was the first large growth of the left breast to be subjected to the method, some concern was felt as to how the heart would be affected by the requisite current applied so near it. It was accordingly decided that the central part of the growth should be devitalized and sterilized by the bipolar method first, reserving the ordinary monopolar cataphoresis for the sterilization of the edges. This was accomplished by attaching the negative wire to a cotton-covered brass disk electrode about one and a half inches in diameter with the cotton saturated with liquor potassii arsenitis (the arsenic of which would be driven in by anaphoresis at the negative pole), the electrode being applied to the center of the growth and held firmly in contact, while the positive zinc-mercury points were inserted about the periphery of the growth in the ordinary way.

When 400 milliampères had been turned on with the electrodes in these positions the pulse showed a slight weakening, probably from too rapid increase. The current was turned partly off for a moment and then turned on more gradually until 820 milliampères had been attained, which was subsequently decreased to 600, at which strength it was maintained for one hour and twenty minutes. The effect of both polarities was very striking, the tissue under the negative disk being changed to a yellowish white and as rapidly devitalized as that about the points, the whole becoming necrosed and blending together. The current was then turned off, the disk removed, the negative wire transferred to the previously arranged negative pad beneath the patient's back, and 200 milliampères turned on for the sterilization of the edges, which seemed complete in another twenty minutes.

The very large slough produced was dressed with carbolized zinc oxide powder until it came away, on the 22d day, after which prompt healing occurred, with healthy edges.

This patient's stoutness had been the means of concealing the fact that she had been suffering from general ill health for some months before the application, the general *malaise* being attributed by her to chronic rheumatism. The incorrectness of this view was shown, after recovery from the operation, by the presence of nausea and dyspepsia. She was removed to the Germantown Hospital some months later for the sake of better nursing, but gradually failed from inability to retain food, and subsequently died of metastasis to the stomach, without recurrence at the original site.

Carcinoma of the Left Breast, with Extension into Axillary Glands.—Mrs. N. K., aged 44, was referred by Dr. J. J. Moylan, of Germantown, in April, 1899.

This patient, who was first seen within a month of the application to the preceding one, and who lived but two blocks away, also presented an instance of acinous carcinoma of the left breast, though but a portion of the outer quadrant was affected. In this case, however, the disease had proceeded to a point of actual infiltration of the skin overlying the disease, and there was one enlarged, movable gland in the axilla, about the size of a horse-chestnut.

She had first noticed the lump one year before. It was now giving pain, and her general condition did not indicate the best of health.

The patient was placed under ether April 13, 1899, and major cataphoresis applied, with the assistance of Drs. Hermance and Moylan. A large gold-mercury electrode was inserted, additional mercury injected, and a current of 400 milliampères gradually turned on, encountering some trouble with the pulse again because of what is now understood to have been too rapid increase. Turning it on again more slowly we easily reached a strength of 500 milliampères. After about a half-hour of steady current flow the whole lump began to soften, which softening included the whole growth at the end of an hour and twenty minutes. Meantime a zinc instrument had been substituted for the gold one, as offering quicker results, and another zinc instrument had been made to penetrate the enlarged gland through its overlying skin, the current dividing itself between the two until the condition of the primary growth permitted the instrument in that situation to be removed.

The after-history of the case pursued the usual course, except that the general condition did not improve, and during the frequent postoperative examinations always made in such cases some induration was noticed in the axillary border of the main scar. This should have been destroyed at once, but the patient's general health continuing poor nothing was done. One year later it was learned that the patient had had this spot treated by a caustic paste, leaving much of the disease still existent. The evidences of general infection were now decidedly pronounced.

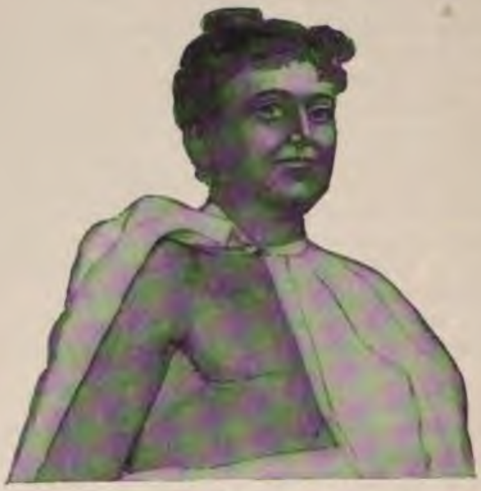


Fig. 74.—Case of Mrs. P. Nine Months After Application, showing a **V**-shaped Linear Cicatrix.

This case shows that 500 milliampères may be easily employed as long as necessary in the left breast, applied to the periphery if the growth is large and in the center if small. The destruction and sterilization of the periphery is, after all, the important part of the work, and this accomplished, the center is necessarily devitalized, considering the periphery as including the costal base of the growth as well as the external edges.

But the most important lesson taught by this case—aside from its illustration of the old, yet incomprehensible, story of a human being living contentedly for a whole year with this monstrous disease just beneath the skin—is the emphasis it gives to the rule that all structures situated between a primary growth and a glandular infection should be destroyed, for the reason that a lymphatic vessel that has conveyed the cells is under suspicion of having given lodgment to some also.

Carcinoma of the Right Breast and Axilla.—Mrs. P., aged 65, was referred by Dr. Charles M. Dalsen, of Philadelphia, with a primary carcinoma of the right breast of two years' known duration. The growth had begun in the lower and outer quadrant of the breast, but at this time the outer half of the organ was involved. The skin was adherent over the center of the growth and was infiltrated, and slightly ulcerated. The growth extended well into the axilla, but no glands were apparently affected. The patient was pale and in poor health, but it was thought wise to give her the benefit of the doubt.

Major cataphoresis was applied October 30, 1901, 600 to 700 milliampères being applied with several zinc-mercury points during three hours. Convalescence was uneventful, but revealed some disease still remaining near the axilla. A second application of 350 milliampères was therefore made March 9, 1902, the current flowing for forty minutes. The excellent scar resulting from these two applications is shown in Fig. 74.

The patient's health remained about the same, anemia being the principal symptom, until her sudden death, September 21, 1902, apparently of internal metastasis, without return of the primary growth.

Carcinoma of the Right Breast and Axilla.—Mrs. S. M. S., aged 57, was referred by Dr. Theodore Saulsbury, of Burrsville, Md., in October, 1902. Seven months before she first noticed a lump in the breast, which became ulcerated and painful five months later. The condition on admission is well shown in Fig. 75, which does not show a movable infected gland of large size in the axilla, which was also present. The patient's general condition was one for much concern, as she was very thin, of muddy color, and with poor digestive capacity. There was, moreover, so much albumin in the urine that a consultation was called as to the advisability of administering ether. As something had to be done, the decision to proceed with the application was formed.

She was accordingly placed under ether October 9, 1902, and zinc-mercury cataphoresis applied with several points to the primary tumor, the enlarged gland, and the intervening tissues, the current standing at from 600 to 720 milliampères for one and a half hours. The uninfected portions of the breast were left undisturbed.

The conditions immediately after the application were shown in a photograph taken the next day (Fig. 76), the three following illustrations showing, respectively, the condition at discharge (Fig. 77), five months after application (Fig. 78), and one year after application (Fig. 79). No further treatment has been required, except to let out a tiny globule of unaltered mercury that produced the irritation at the spot shown in Fig. 78, and the patient is not only able to write at date of publication (two years after treatment) that she is in better health than for years, but has had her breast saved as well.

Before inserting the electrodes a small piece of the growth was removed for microscopic examination and transmitted to the Philadelphia Clinical Laboratory, which reported as follows under date of October 29, 1902: "Mi-

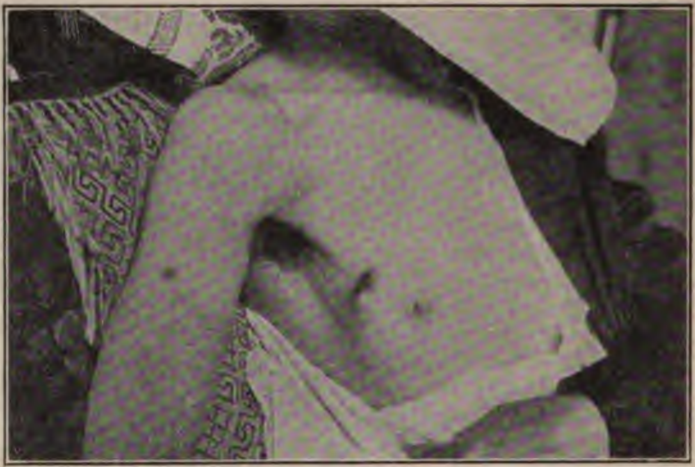


Fig. 75.—Case of Mrs. S. Photograph of Growth, October 9, 1902, Before Application of Cataphoresis.

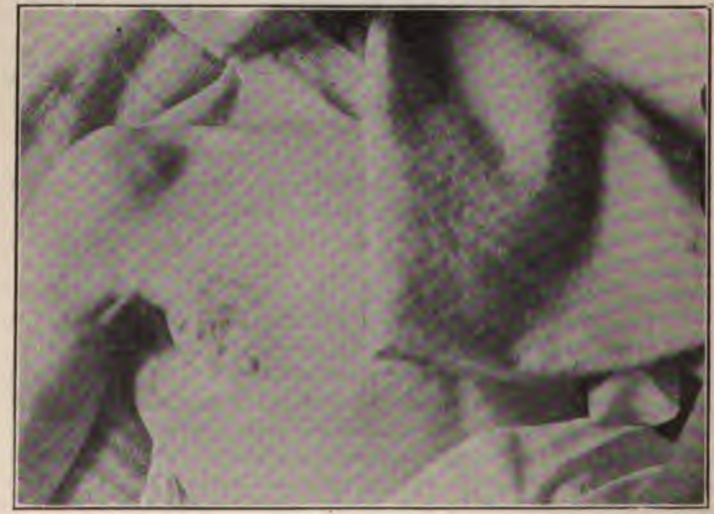


Fig. 76.—Case of Mrs. S. Appearance on October 10th, the Day After Application.

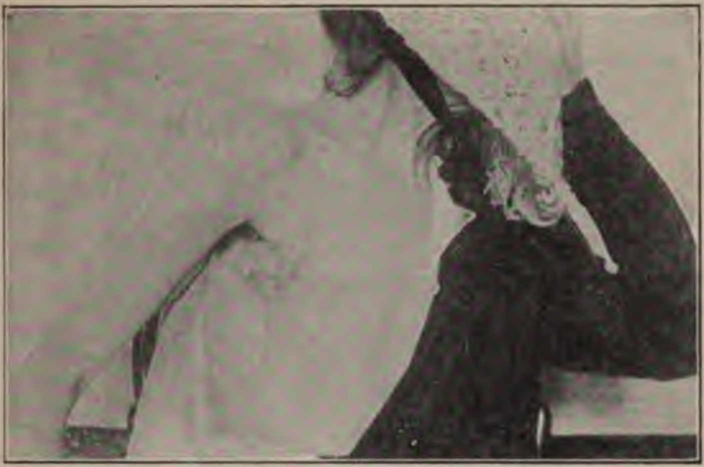


Fig. 77.—Case of Mrs. S. Appearance of Healing Wound on December 3d, Eight Weeks After Application.

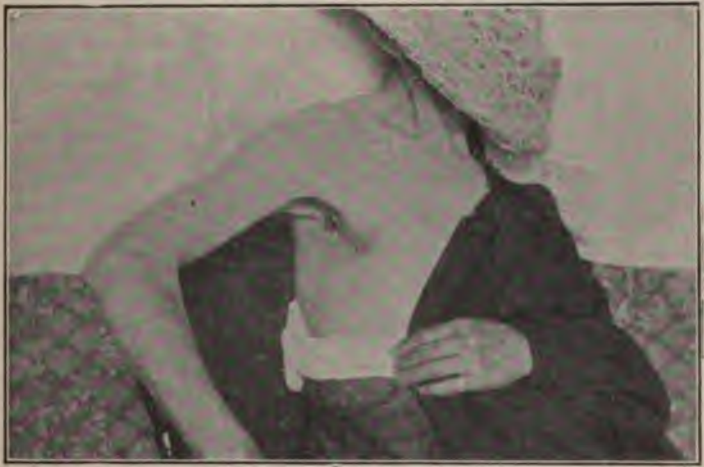


Fig. 78.—Case of Mrs. S. Five Months After Application (Photograph of March 30, 1903), Showing Healed Wound Except Small Spot due to Imprisoned Quicksilver.

croscopic examination showed the presence of large masses of closely packed epithelial cells with but few fibers between. Blood-vessels were well developed. The original characteristics of the tissue had quite disappeared. Diagnosis: Carcinoma."

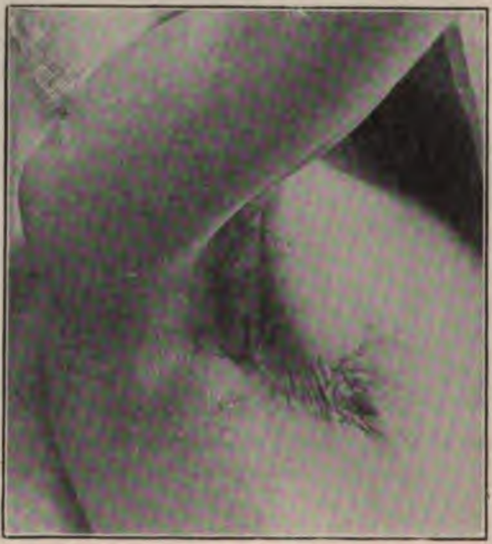


Fig. 79.—Case of Mrs. S. One Year After Application, Showing Healthy Scar and Restored General Health.

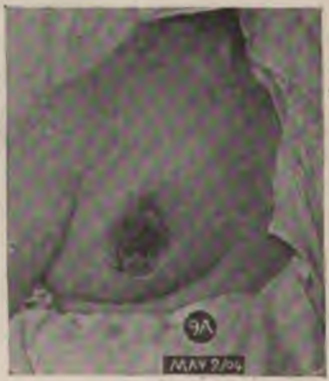


Fig. 79*a*.

The following case was reported by Dr. Amédée Granger, of New Orleans,[1] and is here reproduced with his permission:—

Scirrhus of the Right Breast. Cured.—Mrs. T., aged 67. The affection dated back six months, and was ushered in by occasional lancinating pains in the right breast. These became more frequent, and two months later a small ulcer formed near the nipple. The discharge from the ulcer was bloody and serous. Two surgeons who were consulted by the patient a few days before she applied to me for treatment advised immediate amputation of the breast and removal of the axillary glands. The scirrhus at that time was about the size of a hen's egg.

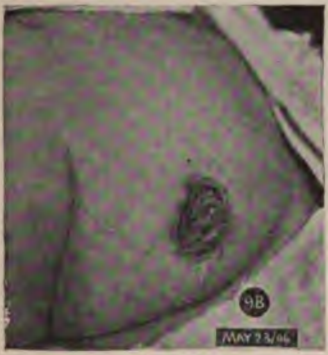


Fig. 79*b*.

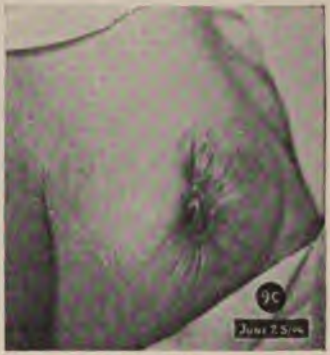


Fig. 79*c*.

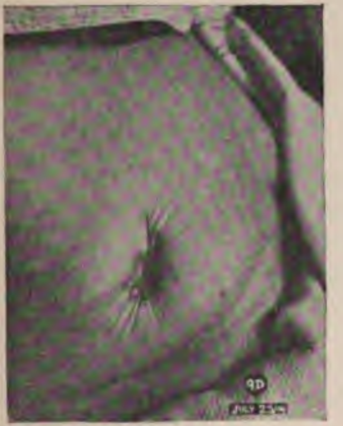


Fig. 79*d*.

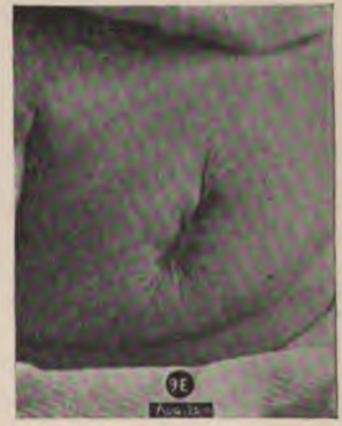


Fig. 79*e*.

---

[1] Journal of Advanced Therapeutics, October, 1904.

On April 25, 1904, the patient was anesthetized, and I made a major application of massive mercuric cataphoresis for one hour and fifteen minutes, with a current strength varying between 150 and 250 milliampères. The eradication was complete. The slough came away on the twentieth day after the application, leaving a clean, healthy wound, which rapidly healed, remaining well four and a half months later.

Fig. 79*a*, from a photograph taken a week after the operation, shows the holes through which the zinc points were introduced into the margins of the growth, the area of destruction, surrounded by the area of sterilization, which shades off irregularly into the surrounding healthy tissue, and between the two, especially noticeable below, the line of demarcation.

In Fig. 79*b*, from a photograph taken about one month after operation, we see the large granulating cavity left after the slough came away, surrounded by a border of newly formed epithelial tissue.

Fig. 79*c*, taken one month later, shows the wound not one-fourth the size that it was the previous month.

Fig. 79*d*, still another month later, shows the wound healed.

Fig. 79*e* is from a photograph taken one month later than Fig. 79*d* and four months after the operation. The scar is narrower than in the previous photograph.

CHAPTER XVI.

THE CATAPHORIC DESTRUCTION AND STERILIZATION UTERINE CANCER.

Cancer of the Cervix.—The difficulties attending the treatment of cancer of the neck of the uterus are greatly increased in practice by the insidious approach of the disease, which is rarely diagnosed by physicians or suspected by the patient, before it has spread beyond its original site and involved structures that cannot be reached by the knife, curette, or any mode of treatment known at present. This unfavorable prognosis after cutting operations has been generally conceded of late, one operator being quoted at the Saratoga meeting of the American Medical Association as saying that he had operated on 482 cases of this disease, of which number but 2 were living.[1]

From experimental observation of the autoinfectivity of cancer, notably summarized in a recent work by Cullen, of Johns Hopkins University, it is evident that this small percentage of cures in operable cases may be due in part to a reimplantation of the growth in the cut edges, though the peculiar richness of venous and lymphatic anastomosis in this location renders the complete destruction of the growth most difficult by any method.

The possibility of reimplantation of the infected cells in the freshly severed edges has been partially provided against in the Byrne method of heat cauterization by the galvanocautery knife, and more recently by the electro-thermic hemostasis of Skene, revived by Downs. While the latter process is somewhat clumsy, and difficult of application through the vagina, owing to the large instruments and great heat required, it is evident that both methods are distinct advances in the treatment of cancer of the cervix by the elimination of operative infection.

A far more thorough sterilization is, however, possible by the use of the electro chemic diffusion of ionized mercury and zinc, for by this method no preliminary opening of the venous and lymph channels is necessary, with possible instantaneous admission of cancer cells, and the sterilization may be carried to more distant prolongations of the infected area by the self-directing flow of the chemicals. The growth is thus destroyed *in situ,* the general direction of the action being controlled by small, easily handled instruments, with the force completely insulated from accidental contact with the vagina and external parts, and without appreciable heat production when properly carried out.

---

[1] Journal of the American Medical Association, July 26, 1902.

As compared with x-radiance, which has been generally abandoned as a remedy for cancer within cavities, this force possesses the advantage of being conveyed through harmless, insulated conducting stems of small caliber, and of being developed within the growth itself, from which point it radiates through the better conducting malignant tissues. Radium alone, introduced in direct contact with the growth, possesses similar advantages of application, but has so far shown but little effect, while cataphoresis is a direct, measurable surgical agent.

The major or the minor application may be employed, as in other portions of the body, but because large doses may be used in this insensitive region without anesthesia the minor method is rendered extremely important in this affection.

Details of the Minor Method in Cancer of the Cervix.—This application may be made at the bedside of the patient, who lies across a firm mattress with the hips well over the side, and with the feet resting on chairs drawn up to the bedside. As considerable current-strengths may be used, the large dispersing pad is employed beneath the patient's back, the mattress being protected from moisture by waterproof material.

The active electrode is a zinc bulb about one inch long and three-eighths of an inch thick, mounted on a suitable shank, the fused wax insulation of which reaches to the zinc surface (one of the uterine zinc-mercury electrodes shown in Figs. 33 and 34 may be used).

The patient having been placed in position on the pad, the electrode is inserted, pressed into the eroded surface, which should touch the diseased part alone, and the current gradually turned on while the electrode is held immovably. A spear-shaped or pointed electrode shown in Fig. 73 may be used if desired. The amount of current attained must depend on the pain produced. Usually as much as 150 milliampères may be borne, and even 250 is at times bearable.

The duration of the application must be at least thirty minutes to be effective, and it should be repeated daily until the amount of total current employed equals, by calculation, the amount employed in a major application, or about 500 milliampères for one hour, unless the parts show sufficient change before this amount has been attained.

When all diseased structures appear to be destroyed and the base sterilized the applications may be intermitted for three weeks, to permit the sloughs to come away and the result to be estimated by touch and sight. Should disease be present at this time a second series should be started, in from three to four weeks from the cessation of the first series.

At the suggestion of my colleague, Dr. Howard R. Swayne, the details of this application have been recently modified in some cases by the substitution of a placement of the pointed electrode by sight instead of touch, a cylindric glass or hard rubber speculum being employed through which the electrode is passed, the patient being preferably in the dorsal position on a gynecological chair. The clay pad may also be placed on the abdomen. The use of the speculum permits the progress of the action to be readily observed.

Applications of this nature, repeated daily for a week at a time, followed by about a week's interval for the estimation of effects, offers great hope for the eradication of the disease in cases that are operable, though, unfortunately, patients too seldom apply for treatment in this stage. Certain inoperable cases may nevertheless be undertaken with some hope of cure, though only palliation is possible in the larger number. As a pure palliative, minor mercuric cataphoresis is most valuable, as it can be relied on to relieve pain, arrest hemorrhage, and remove odor. The method has also the great advantage of being unattended by mortality risks, so far as shown in the author's cases and in the hands of others who have employed it.

Details of the Major Application to Cancer of the Cervix.—This operation differs from the major application described in Chapter XIV in the following particulars: The operation is performed with the dispersing pad and patient resting on an operating table instead of a cot, the table being preferably of wood and well padded, or if the table be made of metal, with the limbs of the patient prevented from coming in contact with the exposed iron framework to avoid burns from straying current.

The active electrode, of which but one can be used owing to the small space, should be of the spear-shaped type shown in Fig. 73 to permit of penetration of the growth, and to present an active surface great enough to prevent polarization at the site of the application.

The electrode is inserted into the growth and from 350 to 600 milliampères is gradually turned on, the heat resulting from this current being concentrated at the small active surface and carefully annulled by repeated douching of the vagina with cold water through a hard rubber tip. With a finger near the electrode each rise of temperature is easily detected and corrected by the water stream. At the end of every twenty or thirty minutes the current should be turned off without shock and the electrode replaced with a new one, freshly amalgamated. At each new insertion a slightly different point of the growth may be attacked.

From an hour to an hour and a half will usually be required for the complete destruction of the average cervical cancer unless the growth be of but slight extent.

Repeated inspections should be made during the application, a miniature lamp inserted within a glass speculum between the stages of the application being the best mode of visual examination, though the sense of touch is the best guide to the completeness of the results, the diseased tissues softening under the treatment.

The after treatment is expectant, the slough coming away somewhat sooner than when the skin surface is involved in the growth.

After the sloughs have come away the parts should be thoroughly examined at intervals of a month to detect the presence of remnants of the infected cells, and a minor application should be promptly made on the appearance of the least doubtful tissue.

The mortality of this operation has been 2 cases in the 8 patients operated upon, the cause of death in the two instances having been peritonitis from the deep extension of the growth.

Illustrative Cases.—*Incipient Carcinoma of the Cervix.*—Mrs. A., aged 49, of Salem, N. J., was under treatment for nervous prostration in June, 1896. In the examination that was made to determine the cause of her condition an irregular ulceration was found surrounding the os. The hardened edges and unhealthy appearance of the ulceration led me to suspect squamous-celled carcinoma, and this diagnosis was subsequently verified, after microscopic examination, by Professor Parvin, who was consulted by the lady and her husband.

The patient was placed on minor applications of zinc-mercury cataphoresis, 100 milliampères being employed daily for six weeks. The average duration of each application was ten minutes, and the electrode employed was a small zinc olive, mounted on an insulated shank, the electrode being pressed into the roughened excavation. At the end of six weeks the whitish eschars produced had cleared off, and the patient was sent home with directions to return for an application every two weeks. The local and general conditions progressively improved under this arrangement, and at the end of six months she was discharged from further treatment. At the expiration of a year she was sent to Dr. Parvin for re-examination, who found at this time no trace of the disease. The cure was permanent and complete, the patient dying in the spring of 1903 of phthisis pulmonalis.

Recurrent Inoperable Carcinoma of the Cervix.—Mrs. C. I., aged 48, of West Philadelphia, was first seen September 24, 1897. One year before carcinoma of the cervix was first discovered, and two months before being seen by the author she had been curetted by a prominent gynecologist, with the statement that a more radical operation was out of the question. Intense and constant pain followed the curettage, and there were frequent hemorrhages and a most intolerable odor. The patient's condition showed every evidence of metastasis, yet it was decided that the minor method would be a valuable palliative, and might do more if the poor general health was due to the local condition instead of to general infection. The minor method was accordingly begun at her home, daily applications of from 80 to 125 milliampères being made for several weeks. As there was but little tissue left after the curettage, the indurated and fixed edges being apparently continuous with the broad ligaments and other pelvic structures, a bulbous gold electrode well covered with mercury was used after the first few applications.

The results were most gratifying in the arrest of the hemorrhages, which had been profuse and weakening, in lessening the pain and removing the horrible odor. As a natural consequence of this saving of blood, and at least partial arrest of the autointoxication from the local disease, the patient gained strength, though still presenting the ominous waxy complexion of metastasis, and walked out for the first time in four months. Hopes of cure were, of course, vain; the metastatic growths continued, causing death some months after the treatment had been discontinued.

Carcinoma of Cervix Without Extension beyond the Organ.—Mrs. E., aged 50, was referred by Dr. Franklin D. Castle, of Philadelphia, October 6, 1903. The patient had a history of uterine disease, but became better after the menopause until in the spring of the present year. About August she noticed frequent discharges of bloody mucus from the vagina; in September Dr. Castle recognized the presence of cancer. Pain, almost constant in incidence, had also appeared.

Examination revealed a destructive ulceration of the cervix admitting the index finger, with the characteristic odor of cancer. After corroboration of the diagnosis treatment was begun by the minor method November 7th, 300 milliampères being given on that day with a small, bulbous, zinc-mercury electrode without ether, and during the following two weeks seven additional applications of 250 milliampères were made, all of 30 minutes' measured duration. Considerable pain now appeared and the treatment was discontinued. Several small pieces of tissue passed a week later, and on December 7th, one month after beginning treatment, a rounded slough, somewhat larger than a hickory

nut was lifted from the vagina, leaving a healed wound that resembled the wound resulting from a vaginal hysterectomy. No further treatment has been required, and at the date of publication, one year after the treatment, there is no sign of either recurrence or of a previously implanted metastasis, her general health being excellent.

The remaining 4 cases, like 2 of those fully described above, were all instances of extensive involvement of the periuterine tissues, 2 having been previously operated on by the knife. Two were temporarily improved and 2 died of peritonitis, as previously stated, before full recovery from the operation.

Judging from the two cases of incipient cancer reported, it is hoped that the method will result in completely eradicating the disease when the patient can be seen in this stage.

Cancer of the Body of the Uterus.—The author regards hysterectomy as preferable to cataphoresis in cancer distinctly confined to the corpus, as the whole of the disease is thus capable of removal without infection of the edges of the wound. Cataphoresis has been employed in but 1 such case, in a patient referred by Dr. Samuel G. Slaughter, of Lynchburg, Va. This case was too far advanced for hysterectomy to be suitable, and the minor method, under unfavorable circumstances, was followed by temporary improvement.

CHAPTER XVII.

THE CATAPHORIC DESTRUCTION AND STERILIZATION OF RECTAL CANCER.

CATAPHORIC destruction and sterilization is in many respects the ideal method for the treatment of cancerous growths of the rectum and perirectal tissues. It offers peculiar advantages for the destruction of external growths involving the tissues about the anus, for these may be destroyed bloodlessly and the surrounding tissues sterilized with great thoroughness in spite of their considerable vascularity, while growths in the middle or upper portions of the rectum may be destroyed with equal thoroughness without interference with the sphincter. These advantages can only be fully appreciated in actual practice.

It should be added, also, that experience has shown that, though full anesthesia is required for major applications to the rectum, as in other painful operations in this region, heavy currents applied to the rectum have the advantage of stimulating the heart and respiration to fuller action, rather than inhibiting them somewhat, as when applied to the neck, rendering the anesthesia itself less dangerous than usual.

The pain accompanying any application to the anal region will usually necessitate general anesthesia, though in mere ulcerative processes above the lower third of the rectum much can be done by repeated minor applications. Large growths in either situation demand a major application.

Details of the Major Application in Cancer of the Ano-rectal Region.—The dorsal position is usually best for the major application, the patient and apparatus being disposed as described in the preceding chapter, the legs supported by leg-holders, and a deflated Kelly pad or a piece of rubber sheeting being placed between the negative pad and sacrum to divert the return current away from the nearest parts, and to act as a drain for the cold water irrigation of the outer portions of the rectum during the application.

For anal and external growths the best active electrodes are the No. 1 breast variety, six to eight of which should be attached to the treatment binding post ready for use, of which from three to six should be used simultaneously.

For growths within the rectum the rectal electrode is essential, or in those low down the No. 3 breast may be used, insulated to a point near the end. Several electrodes should be ready, though but one can be employed at a time above the anus owing to lack of space. These electrodes are to be inserted preferably by touch, with the finger protecting the point until it is made to enter the growth. The same care in watching the local temperature produced at the site of the application is to be employed as in major applications to the neck of the uterus, a hard-rubber pipe being inserted alongside the electrode through which a little cold water is admitted into the rectum whenever the finger shows an unpleasant rise. This precaution is only necessary when endeavoring to force a heavy current through a comparatively small electrode contact. At intervals of twenty minutes or so the current should be turned off and the electrode replaced by another freshly amalgamated one, which may be placed in a slightly different position, thus gradually destroying all portions of the growth and sterilizing its various ramifications. The amount of the current and its duration must depend entirely on the judgment of the operator, assisted by inspection through a speculum, but is mainly governed by the sense of touch, as it is a striking fact that carcinomatous growths lose their hardness completely when devitalized in this way.

After-treatment.—The after-history of a case in which the major application has been made is very simple. Pain will rarely persist longer than the effect of the ether, but, should it remain longer, it may be lulled by the administration of morphine, which in some cases has the further advantage of partially locking up the secretions until the slough comes away, from seven to fourteen days later, when the passage of the slough will be followed by normal fecal evacuations. In one case in which an obstructive stenosis had existed for some time before the application the feces were evacuated the day after application, the hardened parts having contracted at once to a degree to make this possible.

As soon as odor develops the site of application must be frequently irrigated with solutions of hydrogen dioxide, potassium permanganate, or creolin, and when the bowels begin to move the feces should be kept liquid by daily doses of a teaspoonful of Epsom salts in a cup of hot water, taken before breakfast.

At the end of the fourth week an examination will usually show that no evidence of the disease exists, its site being occupied by a narrowed canal with healthy walls. Our patient is evidently well, if there are no diseased glands or other metastatic developments; but it is at this point that we should insist that our duty and the patient's interest require that we make a thorough examination of the site of the disease every four weeks at first, and later at greater, but regular, intervals, until a sufficient time has elapsed to exclude the possibility of some cells having been overlooked. It is lack of this after-observation that has doomed many cases to failure that might have been saved after other methods of local eradication. On the slightest suspicion of nodular formation at or near the site of the healed area a minor application with a zinc-mercury point should be made, and this can be done effectively under cocaine if repeated sufficiently often, thus completing the effort at final eradication that would have failed without this precaution.

Illustrative Cases.—*Inoperable Adenocarcinoma of the Upper Rectum.*—Mrs. V., aged 50, of Pottsville, Pa., was first seen in October, 1895. She had been ill for twelve years, the main feature of the case being an offensive rectal discharge that resulted in many stools and great impairment of health. There was a history of twenty-five stools per day, of dark color, liquid consistence, and most offensive odor, and the patient complained of constant pain in the left groin. Her color was poor and general health bad.

On October 10, 1895, she was placed on minor zinc-mercury applications, administered daily with the hollow bulbous zinc-mercury electrode (Fig. 73), the insertion of which was facilitated by keeping a cushion of albolene, by injection through the electrode, in front of the instrument. This enabled the proper placement of the electrode to be comparatively painless, and it was found that the oil, though a nonconductor, did not prevent the flow of the current when the instrument was in contact with the ulcerations. It is probable that it was of service in preventing useless diffusion.

The current-strength at first was 40 milliampères, which was later increased to 100 by the expedient of passing a little 4 per cent. cocaine solution through the electrode after placing it in position. No note was made of the duration of these applications, but at this time the practice varied between the limits of five and fifteen minutes—the latter length of time but rarely.

Under this active treatment a great change for the better appeared in the character of the discharge, its offensiveness abating and the general condition improving. At this time a living fragment of the growth was detached by the electrode manipulation, and this was kindly examined by Dr. Alfred Stengel, who pronounced the growth an adenocarcinoma. After six months of almost daily applications the patient returned to her home so greatly improved that there were but two stools per day, of improved consistence and character. At last accounts, some three years later, she remained well, but her present condition is unknown.

During the latter part of the treatment the applications were made as far up as eight inches from the anus.

Recurrent Carcinoma of Rectum.—The mother of a physician of western Pennsylvania, aged 60, was first seen October 26, 1901, suffering from a recurrent carcinoma in the ischio-rectal region. The original growth involved a portion of the sphincter and had been removed by a Pittsburgh surgeon ten months before by a modified Kraske operation. When seen a sinus was found to the left of the anus with infiltrated and indurated edges, communicating with a cavity about two inches in depth, the whole growth being about the size of a lemon. The rectal mucous membrane was intact and apparently healthy.

At the application the cavity was filled with liquid mercury, and into the mercury was inserted a gold tubular electrode, amalgamated, the two together constituting a mercuric electrode that accurately fitted the cavity in the center of the growth. From 400 to 650 milliampères was maintained for one hour and fifty minutes. During the passage of the current the induration melted down, the progress of the sterilization being determined by the increasing disappearance of the induration. The application was well borne, destroyed the odor of the discharge, and relieved the pain. After the separation of the *débris* the cavity very nearly closed by granulation.

Her condition six weeks later was greatly improved; but it was at this time thought best to make another application, as a part of the wound had not healed and was suspicious.

On December 15th she was, therefore, again anesthetized and the process repeated with from 200 to 300 milliampères. It was only necessary to keep up this application forty minutes.

The healing was complete after the second application, and in June, 1902, her son reported the disease apparently cured, though the patient was weak from a recent attack of the grip. She remained in reasonably good health for about a year, when death occurred from probable metastasis.

Annular Carcinoma of Upper Rectum.—Mr. T., aged 44 years, was brought to me from Campello, a suburb of Boston, Mass., August 1, 1902, with the following history: He had been in the possession of excellent health until about nine months before, when abdominal troubles, supposed to be of a dyspeptic nature, brought him under the care of his family physician. Not finding relief, he went to California in the spring of 1902, and on his return, in April, was found to have lost twenty-six pounds in weight. Obstruction of the bowels finally developed. He was examined by Dr. Cabot, of Boston, in June, and carcinoma of the rectum was clinically diagnosed, the diagnosis being confirmed by the microscope.

On examination the finger encountered a firm constriction about five inches from the anus, the lumen of which would not admit the distal phalanx. The constriction was cylindric, apparently more than an inch long, and the edges were ulcerated and emitted the characteristic odor of malignant disease. For some time the ribbonlike stools had been replaced by watery discharges only under the action of salines. The patient's color was good, but he was greatly emaciated and suffered from pain in the left groin.

Notwithstanding the unfavorable clinical evidences of metastasis the patient was admitted to a private hospital and on August 3d he was etherized and a major application of zinc-mercury cataphoresis applied as described, with the assistance of Drs. Hermance and Frank White. A current of 500 milliampères was gradually attained and kept up for sixty-nine minutes, exclusive of the time necessary to change and readjust the electrodes. At the end of this time all portions of the growth appeared soft to the finger, and examination with a lighted proctoscope showed the diseased area changed to a grayish white.

On the sixth day the general comfort of the patient was disturbed by a rise of temperature to 102° F., with the development of localized swelling in front of the pubes and inability to void the urine naturally. Both of these symptoms persisted for several days, during which time an increasing quantity of *débris* passed from the rectum, a bedpanful of necrosed tissue finally passing in a single stool, followed by normal fecal passages. The patient went home at the end of three weeks.

On September 22d I examined the patient and found the parts healed, soft, normal mucous membrane covering the site of the growth, but there was apparently a valvular constriction produced by scar tissue on the anterior aspect. The evidences of general metastasis still persisted, showing that the excellent local result had probably been attained too late for an actual cure.

The general ill health continued after the patient returned to his home, resulting in death at the end of about six months, without recurrence of the disease in the rectum.

This case is a comparatively recent one, and was therefore treated by the most approved technique so far developed, the use of the cooling current of water permitting a thorough destruction of the local growth without any deleterious heat effects in the rectum below the growth, and without interference of any kind with the sphincter. The amount of devitalized fragments discharged during the second week was most remarkable, a quantity described by the nurse as a bedpanful having come away at one time, besides a number of separate fragments previously. The relief of the fecal obstruction was immediate, and the patient's general condition improved so much for a time that had not the pain which he had complained of for several months failed entirely to be relieved we would have felt doubts of the presence of glandular infection within the abdomen or other metastatic deposits.

A study of the history of this case prior to the application is also interesting and instructive. In November, 1901, a person, previously in good health, complains of abdominal symptoms, for which he receives treatment directed toward a supposed digestive disorder. Not finding relief, he gives up his business in the spring and goes to California for the possible benefits of the change. While there and on his return in April he is worse, having lost twenty-six pounds' weight in spite of a moderate physique, and it may be added that this loss was shown to have been mainly abdominal, the walls of which became remarkably flaccid. The intestinal sluggishness and pain finally culminated in obstruction and the discovery of the carcinoma in the following June.

An important deduction from these facts is that, since the carcinoma when discovered was confined mainly to the rectal walls, and not extensively attached to the surrounding structures, it must have existed so long before the appearance of the first symptoms in November, 1901, as to have given rise to extensive metastasis at that time, for the general symptoms could not have been due to the local growth alone.

In other words, this case was only curable by present methods in the stage in which the symptoms could only have been those of simple constipation. After November the question of a remedy concerned only the best palliative. Such a history emphasizes the importance of a thorough examination of the stools and of the lower digestive tract, and the medical attendant need not wait until he has developed a technical expertness in the use of rectal specula before he investigates these cases. The examining finger is all that is needed to make a diagnosis of rectal cancer in 99 per cent. of the cases, and the *tactus eruditus* is but slight, indeed, that is not sufficient for the purpose.

Recurrent Carcinoma of the Rectum.—Mrs. E. C., aged 52 years, who was referred to me by Drs. Benham Snow and J. Griffith Davis, of New York, in January, 1903, had been of costive habit for years, but after the menopause, three years ago, the constipation was pronounced, and occasionally she would have some bleeding from the rectum. In June, 1902, she consulted Dr. Davis, who called Dr. Hermann J. Boldt in consultation. A diagnosis of colloid carcinoma of the lower rectum was made and, on the twenty-fourth of June, Dr. Boldt removed the growth and gave an unfavorable prognosis. In November she was re-examined and a recurrence found. The case was now placed in the care of Dr. Snow, who applied Rœntgen rays for several months, and, as the growth was partly external, considerable benefit was derived from the radiation, though the upper portion of the growth progressively increased.

On January 25, 1903, the patient was admitted to St. Elizabeth's Hospital, New York, and, at Dr. Snow's request, I made a major application of zinc-mercury cataphoresis, assisted by Dr. Herman Grad, of New York.

The growth at this time involved the whole periphery of the anal scar and both labia of the vagina nearly to the clitoris, the perineum having been removed at the first operation, and extended up the rectum about three inches, completely blocking its lumen. The anterior wall of the vagina also appeared to be distinctly suspicious.

The patient was placed in the position described, three pointed zinc-mercury electrodes were inserted in different portions of the growth, and 500 milliampères was gradually attained during the first half-hour, afterward increased to 1000 milliampères. This large current was maintained for more than an hour, the whole operation consuming two and a quarter hours. The immediate softening of the whole mass was a most interesting result to the onlookers.

The patient suffered little or no pain subsequently, and three days later was taken to her home, some two hours' journey. Dr. Davis reported that the slough, quite a large one, came away February 7th, bloodlessly; that fecal evacuation had been resumed, but that she suspected several minute nodules near the urethra would need further treatment. The whole of the vast surface exposed by the slough appeared to be healthy.

The patient was therefore readmitted to the hospital, and on the 22d of February was again etherized and the doubtful spots situated on the upper portion of each labia majora and just below the meatus urinarius were destroyed by the simultaneous use of several zinc-mercury points with a current of from 400 to 500 milliampères for thirty-five minutes.

The site of the previous operation, one month before, was found to be represented by a most symmetric, clean excavation in the position of the anus, about three by four inches in outside dimensions, beautifully healed over. The anal sphincter was, of course, entirely destroyed.

The patient again returned to her home, but it was later found that the disease existed in the vagino-vesical septum, where its presence was suspected at the original application, and the disease recurred, with a finally fatal termination, in spite of Dr. Davis's devoted care and attention.

Recurrent Carcinoma of Rectum.—Mr. P. B., aged 75, of Reading, Pa., was referred by Dr. W. F. Marks, in August, 1903. The patient had had hemorrhoids for twenty years, malignant disease supervening two years ago. Four months before being seen a growth had been excised by a surgeon in Reading.

Examination showed a large, fungating carcinoma surrounding the anal opening and extending four inches up the canal, with practical obliteration of its lumen. The patient was emaciated and anemic, and suffered from constant agonizing pain.

Notwithstanding the age of the patient, a major application was determined upon and was made August 30th, after the technique employed in the case described above. From 700 to 800 milliampères were employed with four zinc-mercury points, the duration of the application being one and a half hours.

The patient bore the anesthetic and application well. During the following night there was an almost constant discharge of feces spontaneously, the softening and devitalization of the growth reopening the obstructed rectum. The slough came away in about fourteen days, leaving a remarkably clean wound, with soft edges.

During the application it became possible to insert the finger through the stricture produced by the disease, revealing disease on the prostatic wall of the rectum at a situation immediately beneath the prostate. This observation rendered a guarded prognosis necessary, and led to a second application to attempt the destruction of nodules in this situation, which was made October 22d. Meantime the patient's health had greatly improved, the bowels moved regularly, and he was able to go about the house for the first time in several months. At the second application 200 milliampères were applied from a single electrode for thirty-five minutes.

Two months later the parts had healed sufficiently to allow of a thorough exploration of the rectum above the parts treated, and an additional suspicious nodule was discovered. A third application was therefore made December 13, 1903, of from 300 to 600 milliampères. The patient, unfortunately, failed to regain strength fully after this application, and died about one month later.

The final untoward result in this case illustrates the need of an absolute command of the patient by the physician, totally unhampered, if this dreaded disease is to be fought successfully. It was my wish to have this patient near at hand after the second application for such minor treatment as observation suggested, but the lack of suitable accommodations for free patients at that time made this impossible, necessitating an effort to accomplish results at once that should have been spread over a longer time.

Sarcoma of the Sacrum.—Mrs. C. A., aged 26, of Royersford, Pa., applied for treatment October 1, 1903, with a hard tumor nearly filling the pelvis, examination by the vagina and rectum showing it firmly attached in its whole extent to the inner wall of the sacrum.

She had had two confinements, which were terminated by instrumental delivery, both children dying in childbirth, and a more recent confinement, terminating seventeen months before being seen, in which the child was delivered normally, without instruments, and was living. The tumor was not discovered until March, 1903, when the baby was 11 months old.

The progress of the growth was noted by her physician for several months, and she was finally sent to a Philadelphia hospital, where an opening was made in the median line of the abdomen. The true nature of the growth was then discovered by the surgeon, and the wound was closed without effort at removal of the growth, which was pronounced inoperable. This was in September, three weeks before coming under the author's observation. After leaving the hospital she was sent by her former medical attendant, Dr. James C. Mewhinney, of Royersford, to Dr. W. W. Keen, of Philadelphia, who concurred in the diagnosis of sarcoma of the sacrum, and stated that an operation would probably be fatal, and surely result in paralysis.

The patient's general condition was subnormal, she being anemic, thinner than usual, and beginning to suffer from stricture of the rectum. An attempt to destroy the growth was, nevertheless, determined upon.

October 5, 1903, a major cataphoric application was made, with the kind assistance of Dr. J. E. Porter, of Pottstown, and in the presence of Dr. Mewhinney. The patient was placed with her right side resting on a large pad, a portion of which extended up the back between the shoulders and in front on the abdomen, as a large current was evidently needed. It was decided to make an opening through the unaffected skin above the anus with the cataphoric action itself, with a view to saving the anus and sphincter, the formation of a channel through the skin, coccyx, and lower end of the sacrum by the electric action avoiding all opening of vessels. A slit was accordingly made in the skin, and a large, stout, amalgamated zinc electrode with sharp point was thrust into the tumor with a finger in the rectum as guide, grazing the apparently softened coccyx. This instrument was uninsulated, the purpose being to make a wide opening for the subsequent passage of the devitalized tissue. A strength of 1000 milliampères was shortly reached, when, the necrosis extending and showing signs of heating, three other more slender electrodes, each about seven inches long, were inserted alongside the

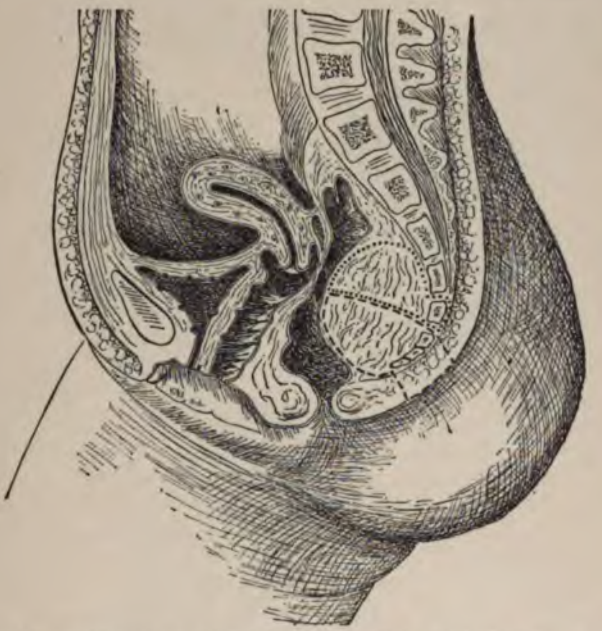


Fig. 80.—Diagram of Medium Section of Pelvis and Sarcoma. The portion destroyed by the first operation is inclosed by a line of dashes, and includes the last three bones of the coccyx. The remainder of the tumor, including the first segment of the coccyx, was destroyed by the second operation, and is indicated by a dotted line.

first to a total depth of four and a half inches. The current was then raised to 1600 milliampères, which was maintained for three hours, being lowered somewhat during the last hour.

The application was well borne. At its expiration three burns were found at different points under the negative plate, due to this plate being too stiff to adapt itself properly to the contour of the body. These skin necroses gave the patient more subsequent discomfort than the wound proper, but ultimately were covered with soft cicatrices.[1]

Aside from the accidental necroses of the skin, the after-condition of the patient was comparatively comfortable, the skin and three segments of the coccyx coming away in sixteen days, and a large portion of the tumor, a piece about the size of a fist, shown on a reduced scale in Fig. 81, coming away on the twentieth day, with a sharp hemorrhage, readily controlled by pressure.

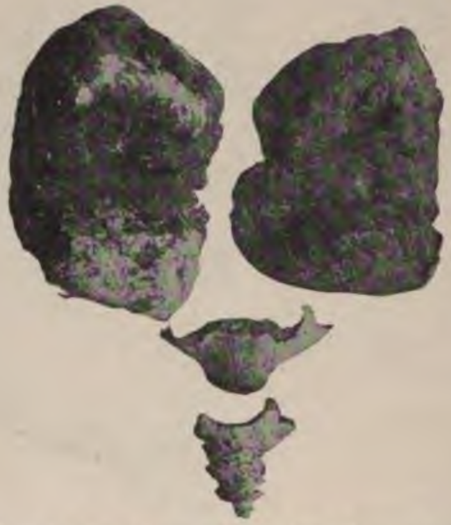


Fig. 81.—The Two Pieces of Devitalized Sarcoma Tissue and the Segments of the Coccyx, as they Appeared after Separation (Reduced to One-fourth Size).

After the separation of the slough, which, by the way, was practically inodorous having been dressed with carbolized zinc oxide powder, the conditions were as follows: There was an opening about three inches in diameter

---

[1] Since the date of treatment of this patient the negative pad has been changed from a cotton compress to a clay pad, resulting in an entire elimination of burns of this character.

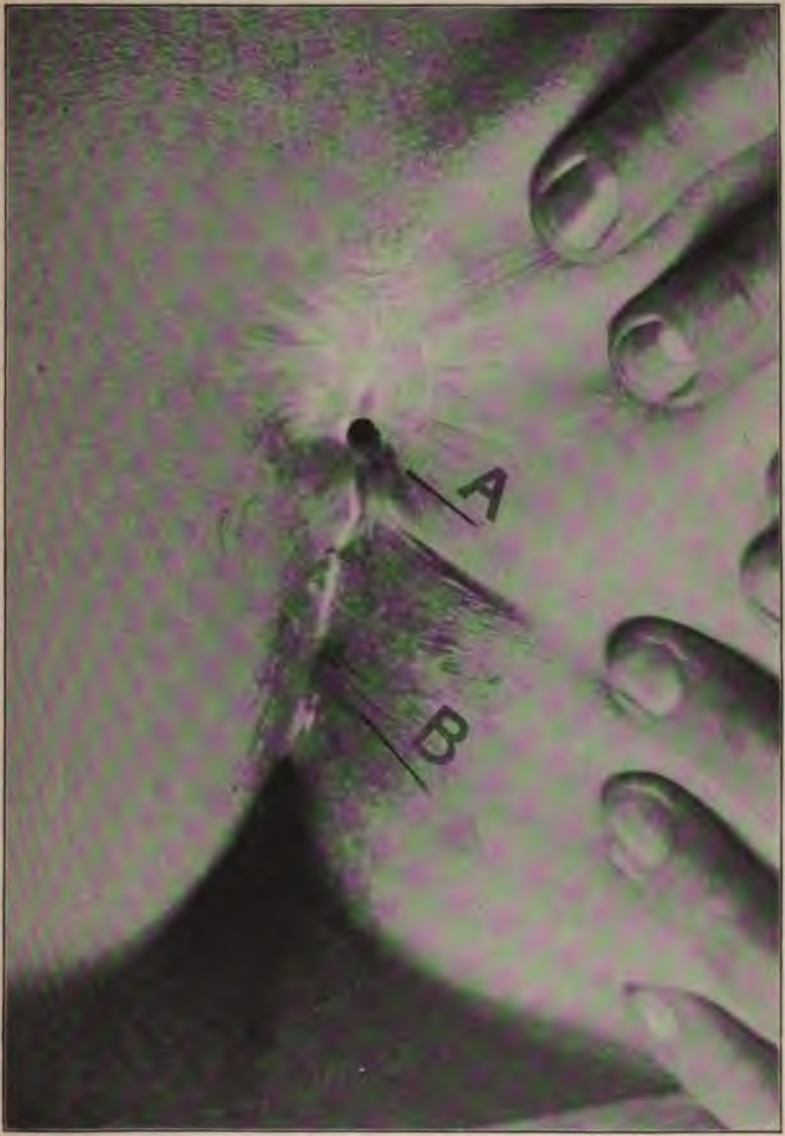


Fig. 82.—Photograph of Scar Seven and One-half Months after Destruction of Sarcoma of Sacrum (Full Size). *A*, sinus leading into rectum; *B*, anus.

extending into the rectum, the lower edge being one and a half inches from the intact anus. At the bottom of this opening, which was two inches deep, the red tissue of about one-half of the tumor was visible (Fig. 80). That this was a portion of the tumor was clearly shown by vaginal and rectal examination, the finger now being able to be hooked over its upper border.

On November 2d a second major application was made through the opening, with long electrodes so insulated as to protect the healthy edges of the opening. A current of 1600 milliampères, later decreased to 800, was employed for one and three-fourths hours, with four electrodes. Careful attention to the dispersing pad prevented accidents in this situation at this time.

The devitalized tumor, about the size of a large fist, came away cleanly, without a drop of blood, in seventeen days, leaving absolutely no sign of remnants in its former situation. Examination through the wound showed the lower third of the sacrum roughened on its inner wall, and the devitalized first segment of the coccyx was picked out of the wound painlessly two weeks later (Fig. 81).

During December efforts were made to direct the fecal discharges through the natural anal opening, all discharges having thus far passed through the operative opening owing to the destruction of the posterior rectal wall. Several hard rubber tubes of various sizes and curves were inserted into the rectum through the anus, but all failed of their purpose and were finally abandoned, the fecal discharges continuing to pass through the wound until its gradual narrowing, late in the winter, diverted the feces into the natural channel through the anus.

The patient sat up in the second week of December, went downstairs on Christmas day, and walked out January 10th. On January 13th she had the first natural movement through the anus.

At the present time, more than one year after the last application, the patient is in unusually good health, with no evidence of fullness or growth of any kind in the pelvis or elsewhere. She walks and sits easily, and the opening is so small as scarcely to admit a small quill (Fig. 82); it is believed that it will ultimately close entirely.

At the time of the second application a small portion of the growth was removed and sent to the Philadelphia Clinical Laboratory for histologic examination. The report characterized the growth as a fibromyxosarcoma.

Inoperable Myxosarcoma of Perirectal Region.—T. McD., aged 44, was first seen March 25, 1904. The patient had been confined to bed for some time with an enormous protuberant growth of the perirectal tissues, shown in its superficial aspect in Fig. 83. Nearly a year before that time his physician, Dr. J. J. Burke, of Philadelphia, discovered lumps high up in the rectum and took him to a distinguished surgical authority in Philadelphia. In October, 1903, he was admitted to the Presbyterian Hospital and an incision was made, but the case was found to be inoperable, the diagnosis of myxosarcoma being confirmed by the microscope. His condition had grown steadily worse from the first discovery of the growth, fresh portions of the growth continually breaking down and discharging a mucoid material.

Examination showed an indurated tumor of the right side of the anus, eight inches wide by a foot long, the normal tissues of the anus being replaced by the eroded and friable tissue where the growth had broken down. The patient was extremely pale, and had lost much weight in the past six months.

On March 29th the patient was anesthetized and 1400 milliampères, decreasing to 800 because of poor acid batteries, was employed for two hours and twenty minutes, with seven long zinc-mercury electrodes thrust deeply into the growth. The application was well borne, and a large slough came away on the eleventh day.

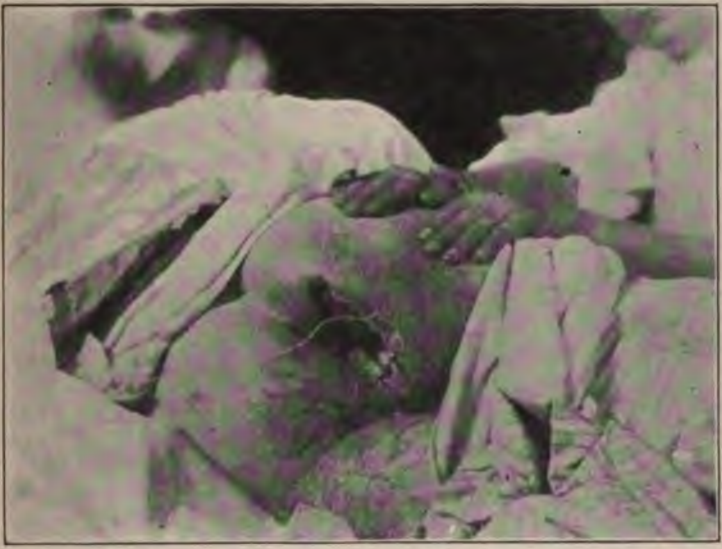


Fig. 83.—Photograph of Case of T. McD. Taken Before Second Operation, Showing Large Size of External Growth at that Time. Two Electrodes are in Place, Ready for the Current to be Turned on.

On April 15th a second operation was done, the photograph (Fig. 83) being taken just as the current was being turned on. From 1600 to 1700 milliampères were used with eight electrodes for one hour and twenty-six minutes, new dry-cell batteries being employed.

On May 10th a third operation was done under ether, 1250 milliampères being employed for two and a half hours.

The several operations having each improved the patient's condition very greatly, and the disease being left in scattered spots leading high up the rectum, in situations somewhat dangerous for a major application, he was now placed on biweekly office applications, as he was now well able to make the exertion, a separate spot being treated at each *séance* by puncture with 100 to 150 milliampères.

The patient is still under treatment at date of publication, the present appearance of the disease area being shown in Fig. 84. He walks easily and has resumed work at his occupation.

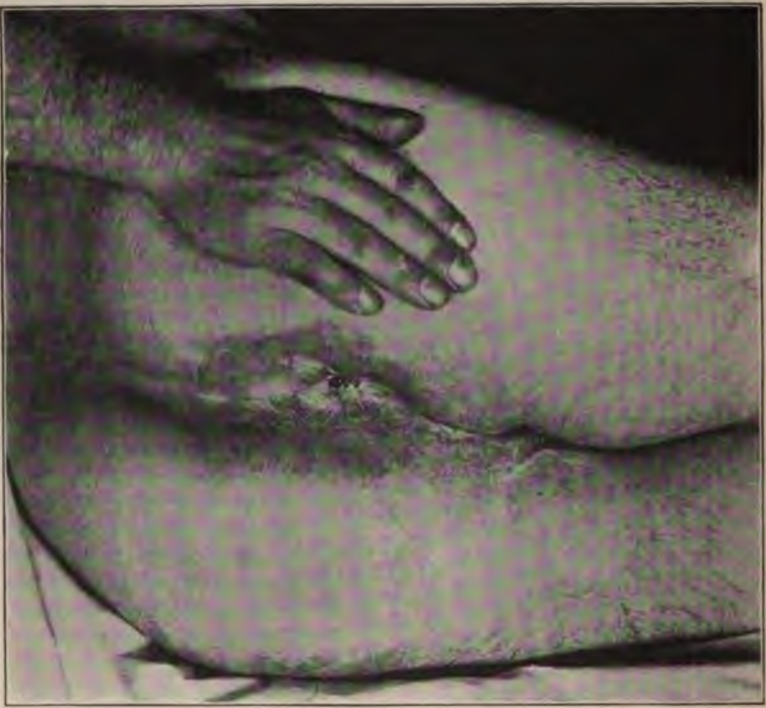


Fig. 84.—Photograph of Present Condition of T. McD. Taken Six Months after that Shown in Fig. 83. Some Disease Existed within the Rectum at this Time, but all External Parts were Healthy.

The following interesting case of Dr. Howard R. Swayne, of Philadelphia, is reported here with his permission:—

Epithelioma of the Rectum.—Mrs. H., aged 57. In 1902 she was operated on by the knife for cancer of the cervix uteri, in its early stages, and an apparent cure effected. For some time prior to May 4, 1904, she had the sensation of a foreign body in the rectum, later accompanied by pain. At the date mentioned Dr. Swayne discovered a growth on the posterior aspect of the rectum about three inches above the anus. The diagnosis of epithelioma being confirmed by a microscopic examination, he determined upon its eradication by the author's method, and she was accordingly placed under ether and 500 milliampères applied with the spear-shaped rectal electrode for one hour. There was considerable secondary hemorrhage on the fourteenth day, on the separation of the slough, readily controlled by an injection of Monsel's solution in glycerin in the proportions of 2 fluidrachms to 6 ounces.

The patient's general condition, which had been poor, gradually improved, and at the time of this report, six months after the operation, she is in excellent health, with no sign whatever of recurrence.

CHAPTER XVIII.

DISPLACEMENTS AND NONTRAUMATIC RELAXATIONS OF THE PELVIC VISCERA.

THE subject of displacements of the uterus occupies a large share of the attention of practical gynecologists, partly on account of their inherent importance, and partly because the sufferings due to other conditions have been too frequently attributed to the displacement, under the ultramechanical development of the older gynecology, which regarded each elaborately classified bend or tilt as a pathologic entity, to be corrected by a specially shaped pessary. Fortunately for our reputation for common sense, these several bends and tilts, with the exception of retroflexion and prolapse, may now be regarded as of no more practical importance, *per se,* than the shape of the patient's nose. Unless the bend or tilt is accompanied by a catarrhal or hyperplastic condition or by fixation of the uterus or other abnormality, it possesses absolutely no significance. The uterus being normally a most mobile organ, it is readily seen that the chief enemies of its static equilibrium are fixation, on the one hand, and either torn or atrophied supports or undue bulk on the other, and that our therapeutic efforts should be directed to a removal of these more significant accompaniments.

It is most important, also, to ascertain the chronologic sequence of the congestion or hyperplasia and the displacement in cases of mobile prolapse and retroversion not due to laceration, and here is where a singular lapsus occurs in the current views of many gynecologists, who, while fully convinced of the microbic and neural causation of other inflammations, still adhere to the older theory of a mechanical cause for this one. My experience with two classes of young women has convinced me that *the congestion and enlargement of the uterus is the initial lesion in all cases except those due to laceration of the pelvic floor* at childbirth, the displacement being secondary and sequential; the proof of this is the great rarity of prolapse and retroversion in *nulliparous* peasant women who carry heavy weights, and the invariable association of endometritis with the very earliest stage (and doubtless preceding) the prolapse or retroversion of young women of the better classes. This sequence of events applies equally well to puerperal subinvolutions, which are a most fruitful source of displacements and relaxed ligaments. In these cases all admit that the causal condition is the failure of the physiologic changes that normally reduce bulk and replace effete muscular tissues. The hypertrophy necessarily antedates the displacement.

It is not to be denied, of course, that the elevation of an enlarged and catarrhal or subinvoluted uterus by a pessary may, at times, relieve the intrinsic condition of the organ, though it usually fails to do so; but this occasional result is no reason to assume that the displacement or tilt was primary. Unless the advocates of the mechanical theory are prepared to affirm that the bend, tilt, or descent is to act the part of the microbe in this particular inflammation, they should admit that its etiology must be the usual one, and that the uterus has become tilted or prolapsed because it had become heavier as a result of the catarrhal attack. This reasoning does not include the mechanical contributing causes of retroversion and prolapse in non-lacerated cases due to the pressure of a tight corset, lifting weights, or a sudden jar or fall, but explains how these mechanical causes, acting upon an already heavy uterus, are enabled to effect a dislocation of an organ naturally capable of most extensive movements without harm.

The bearing of this question of the chronologic sequence of the congestion and displacement on the practical details of treatment is evident. An actual cure demands that particular attention be paid to the hyperplasia primarily, or to its cause in endometritis, metritis, or other inflammatory conditions that may still exist, and, if the remedy employed be the constant current, a concurrent treatment of the relaxed supports is also gained. A therapeusis aimed merely at the effects of these trophic disturbances—the sagging—is unscientific and at times harmful. What can be worse in its effect upon already weakened muscular structures than placing them in splints by the employment of a pessary? Nature, surely, never designed that a skeleton should exist within the vagina, and if the purpose of the physician in placing one there be not to improve upon Nature's permanent arrangements, but merely to use this means to strengthen the muscles, it should be recalled that the whole teaching of the modern treatment of muscular insufficiencies tends to magnify the value of gymnastics and to discredit support and fixation. Many cases of moderate descent of a too heavy uterus have been rendered permanently incurable by the persistent use of these contrivances, causing atrophy of the vaginal muscular layers and round ligaments. Their only proper indication is in the incurably dilated vaginas of middle-aged or elderly women, where a properly fitting support gives immense comfort, and should be worn, under frequent observation, until senile involution contracts the vagina and renders the uterus smaller.

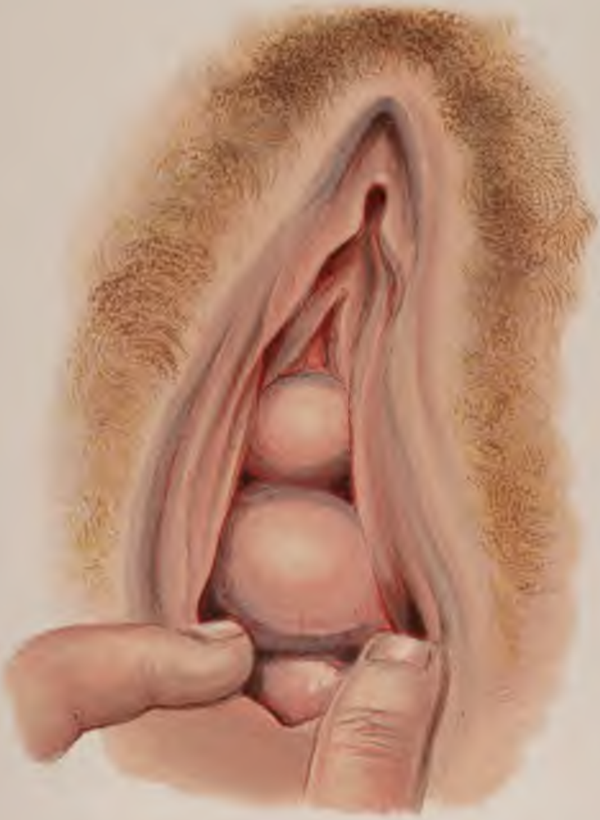
ELECTRIC TREATMENT.

The Author's Method.—The pathologic basis for the use of electricity in displacements and relaxation of the pelvic structures without fixation is of a twofold nature, dependent, on the one hand, on its power to cure inflammatory conditions of the uterus which have produced added bulk or congestion, and, on the other, due to its stimulation of the muscular structures of the uterus itself and its supports. Viewed in either light, its great adaptability as a curative agent is evident, for it associates the two essentials of diminishing the bulk and increasing the power of maintaining it. Clinical results fully bear out these theoretic conclusions, the only exceptions being cases where the muscular structures have entirely disappeared by fatty degeneration.

The details of treatment are largely dependent on whether the organ is freely movable or is fixed in its displaced position by the adhesions of an old pelvic peritonitis or by diseased appendages. In the latter case the applications must be restricted to the vaginal method until a considerable mobility has been gained, when, if it is deemed wise to do so, the intra-uterine treatment may be begun. Here the principal source of suffering is usually due to the inflammatory conditions external to the uterus, which, in addition to being of prime importance of themselves usually constitute a bar to intra-uterine treatment until greatly bettered. Both vaginal mercuric cataphoresis of 50 milliampères or more and secondary induced currents should be used at each *séance*. (For details of method see pages 67 and 132).

If the uterus, on the other hand, is movable and evidently larger than it should be in the particular physiologic condition of the patient, and especially if there be a purulent leucorrhea, positive intra-uterine 20-milliampère applications may be begun at once with an appropriate electrode, followed by the contracting primary induction current. It

PLATE XIX



Traumatic Relaxation of the Pelvic Outlet with Cystocele and Rectocele

[illegible]

is often best to intersperse several vaginal applications between the intra-uterine, if the patient is in a position to receive daily or triweekly treatment.

Nothing has been said, so far, of bipolar induction applications in displacements. Where the induction current alone is to be used, I usually prefer the bipolar method, either within the uterus or vagina, now that I have been able thoroughly to asepticize the instruments, but as I rarely employ the induction current alone in these cases I find it best to use the same monopolar electrode and one insertion for both currents, turning on the induction current after the constant has been turned off.

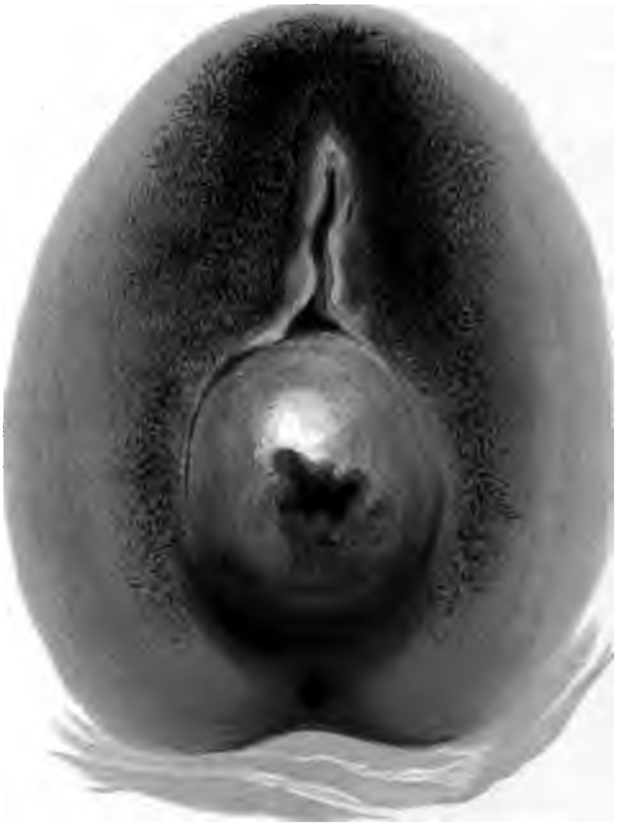
The intra-uterine applications suitable to the curative treatment of the conditions underlying retroflexion or prolapse of nonadherent uteri are exactly similar to those advised in chronic metritis (page 117), and exactly similar contra-indications govern its employment. It is usually wise to correct the displacement, however, immediately before each application. This is best done, in early and painful cases, by placing the patient in the knee-chest position and replacing the organ by manipulation with the fingers, assisted by gravity and by pressing on the fundus through the posterior vault with a pledget of cotton in a pair of dressing forceps. In less tender cases of retroflexion this is not necessary, the repositing being easily and painlessly accomplished by inserting the sound-shaped electrode into the retroflexed cavity with the patient in the dorsal position. Pushing the handle toward the pubis, the tip is now rotated gently forward before turning the current on, the action of the sound being assisted by pressure of the tip of the finger in the posterior vault, when the fundus will usually glide easily into place if not pushed too far back against the promontory of the sacrum. The current is now turned on, as in the treatment of chronic metritis, the contracting induction current usually following immediately after the positive constant application from the same instrument.

There is a distinct contraction usually noticeable in these cases, immediately after the application, and it is extremely rare that it is necessary or wise, in the author's opinion, to follow this application up with any kind of continued support, though some operators use a wool tampon with glycerole of tannin or boroglyceride between treatments. As this distends the vagina, it is apt measurably to interfere with the strengthening of its muscular coats: a distinct object in the electric treatment of these conditions. Without its use the extent of reposition required at each succeeding application will gradually become lessened until that more or less permanent residuum of either retroflexion or prolapse is attained which persists after practical, symptomatic cure, even when all evidences of hyperplasia and inflammation have disappeared.

Such are the most important details in the electric treatment of prolapse, retroversion, retroflexion, and the occasional cases of pathologic anteversion, accompanied, as they usually are in all stages, by engorgement, hypertrophy, or periuterine inflammatory consequences, and this form of treatment is almost always capable of removing pain, weight, discharge, constipation, or other evidence of a morbid condition. It is by no means always possible to entirely correct the backward bend of the uterus or the downward sagging in prolapse, the former being due to a local atrophy of the longitudinal muscular fibers of the uterus and the latter to profound changes in the muscular and fascial supports of the abdominal pressure, but enough improvement may be gained from the cure of the intrinsic uterine inflammatory conditions to take away all unpleasant symptoms and leave the patient unconscious of any departure from the normal position and shape of the organ. The following cases are excellent illustrations of the possibilities of benefit from the measures recommended in prolapse, the cases illustrating other displacements being included among the cases of chronic metritis.

A young lady of 26 years, sister of a physician, who had suffered from menorrhalgia and probably an endometritis since puberty, and had been dilated two years before seeing me with but slight relief from the intense pain at the periods, presented the typical symptoms of almost complete prolapse at time of consulting me, the uterus just presenting at the vulvar outlet. The body of the organ was slightly enlarged and all supports relaxed, the vagina being distended and thin-walled, doubtless from the fact that she had worn a Smith-Hodge pessary for eighteen months. The pain in the back, bearing-down sensation, and weight were so great as to incapacitate her for the most ordinary activities. Of late, she had been sleepless and nervously exhausted. The pessary was at once removed and daily vaginal applications made with both currents for three weeks, with two intra-uterine applications, the patient being told that she would feel worse for a time. Later, intra-uterine applications were employed once a week, averaging 35 milliampères. At the end of two months the uterus was sensibly smaller, remained higher, and gave only occasional symptoms of discomfort. The applications were now made once a month for three months, resulting in com-

PLATE XX.



Hypertrophy and Prolapse of the Infravaginal Cervix in a young negress

[illegible]

plete symptomatic cure. An examination at the end of a year showed the uterus in only moderate prolapse, the vaginal supports firmer, and the patient unconscious of any trouble.

G. R., aged 20, applied at the clinic of the Howard Hospital on August 20, 1897, with complete prolapse of an hypertrophied uterus (Plate XX and Fig. 85). The cervix protruded about two inches beyond the vulva. On passing the sound into the cavity of the uterus it entered seven inches. Bimanual examination showed that the fundus was well up in the superior strait. The condition had lasted two months.

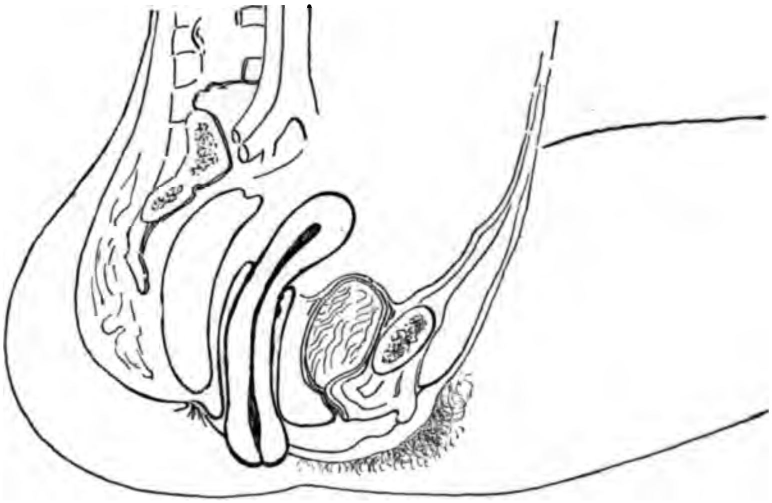


Fig. 85.—Sectional View of a Case of Hypertrophy and Prolapse of the Infravaginal Cervix (see also Plate XX).

The protruding cervix was pushed within the vulva and an intra-uterine application of cupro-mercuric cataphoresis made with 80 milliampères, followed by primary induction current. The vagina was then packed with absorbent wool. On September 3d the uterus was still within the vulva, and the treatment was repeated with a current of 40 milliampères at this time and on four subsequent occasions, without packing the vagina. Two months later the uterus was normal in size and position.

The results of intra-uterine treatment for retroversion and retroflexion are about equal in effect to those gained in prolapse, it usually being easier to secure a symptomatic cure than an anatomic one, particularly in retroflexion, though the anatomic improvement is very great.

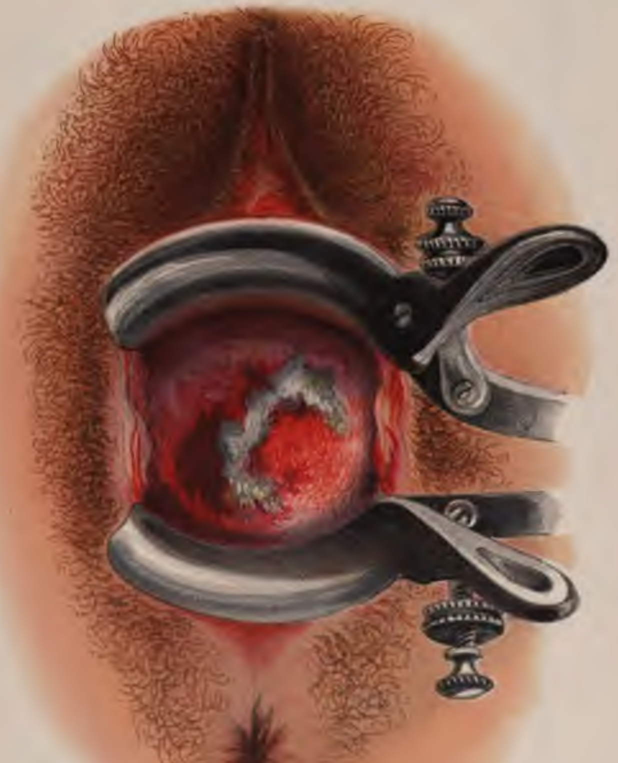
Tripier's Method.—The distinctive feature of Tripier's method of treating displacements[1] is the local application of the induced current to the atrophied fibrils of muscular tissue. This involves the direct, localized action of this current on the convex aspect of retroflexion and anteflexion. In retroflexion the current is localized in the anterior wall of the uterus, therefore, and in anteflexion it is localized in the posterior wall. His directions for the treatment of anteflexion are as follows:—

> The first thing to be done is to lubricate the rectal probe (Fig. 86), although it is the last one to be used, as later the operator would have no disengaged hand to do so. Then a towel should be placed within reach.
>
> The uterine exciter (Fig. 87), having been dried by the left hand, is inserted into the uterus, using for this purpose the left forefinger as a conductor. After this the rectal probe is inserted; this is the most delicate part of the operation; if not well done it might be very painful. The olive must pass the internal sphincter, leaning a little on its upper edge, the concavity of the instrument pointing downward; after this it should be pushed forward, below, and a little to the left. When the olive has thus reached the bottom of the concavity of the sacrum a pause should ensue, then turn the probe while elevating its pavilion so that the concavity of the curvature is turned upward, and in this way cause the olive to face the rear wall of the uterus. It would naturally seem that, on account of the development to the left of the rectal ampulla, the rotation would be easier on that side, but this is not the case; I have always found it infinitely easier to the right, and I have tried it both sides. After pushing the olive from right to left in the concavity of the sacrum it must be brought back to the right, while turning the concavity of the probe more and more toward the right. The pavilion, being held in the hand of the rectal probe, must be slowly elevated during this rotation movement until it has been completely effected. This precaution is necessary, first, in order not to use the uterus roughly; then, that the movement of rotation may be more freely effected.
>
> When the curvature of the probe has been brought parallel to that of the sacrum, then only can the hand be gently lowered, pushing lightly so that the olive may come up, sliding against the wall of the uterus. This last motion, however, must only be accentuated when faradization has begun, in order to give it strength and assure a sufficient contact. The rotation movement just described is not always accomplished without meeting with some resistance; this is sometimes easily overcome, but at other times it may be difficult. The operator should be able to judge according to the impression received by the hand controlling the probe. The most ordinary ob-

---

[1] "Engorgements and Displacements of the Uterus," by A. Tripier, "International System of Electro-Therapeutics," second edition, page G-135. Philadelphia: F. A. Davis Company, 1901.

PLATE XXI.



Carcinoma of the Cervix Uteri.

[illegible]

stacle to this maneuver is the presence of a fecal mass, hard or soft, and it is something that cannot be foreseen. The best way to avoid it is to give the patient an injection of oil before the application.

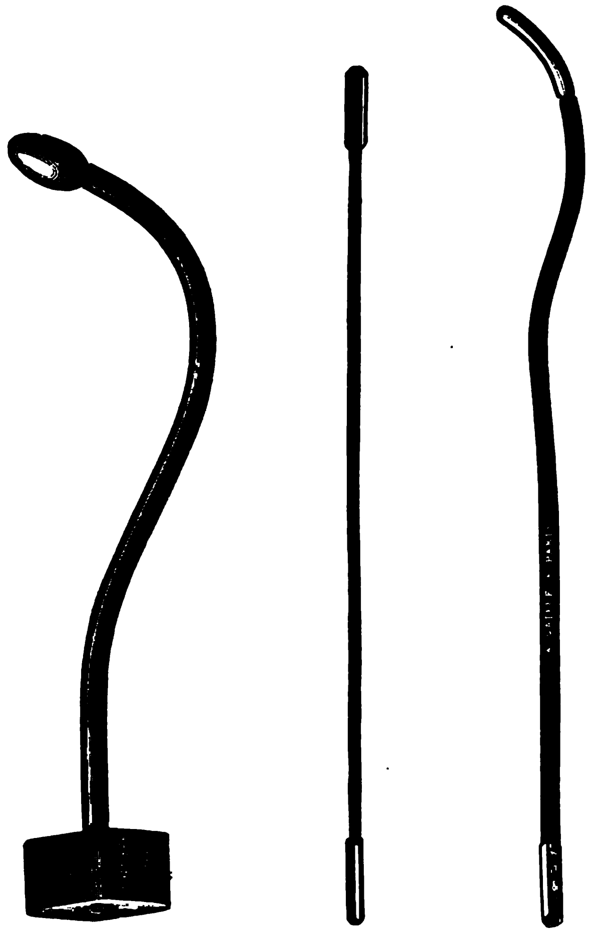


Fig. 86. Fig. 87. Fig. 88.

Figs. 86, 87, and 88.—Tripier's Rectal, Uterine, and Vesical Electrodes for Displacements.

The rectal exciter, once placed, should be held in position; then the conducting cord must be attached with the right hand, which must, at the same time, hold the uterine exciter. It is necessary to get accustomed to manage these two exciters with the same hand, the other hand being free to control the induction current battery and to govern its action. This hand directing the apparatus must, however, be able now and then to assist the other one, if any cause should present itself to modify the connection of the two probes, in accentuating the motion of the rectal probe. The fact is that a definite position cannot always be given at once to the rectal probe. I have already described one obstacle to its progress: the existence of a fecal mass in the intestine. If this should happen to be of any considerable size and a little soft it might cover the posterior wall of the uterus as with a plaster, which could only be penetrated little by little during the application. Muscular contractions form another obstacle to placing the probe. These alter the form of the cavity where the evolutions take place. They are of a flexible nature, and give way under the influence of the current; however, the resistance they present cannot be overcome at once, and it is by interrupting the rotation during the application that this can be avoided.

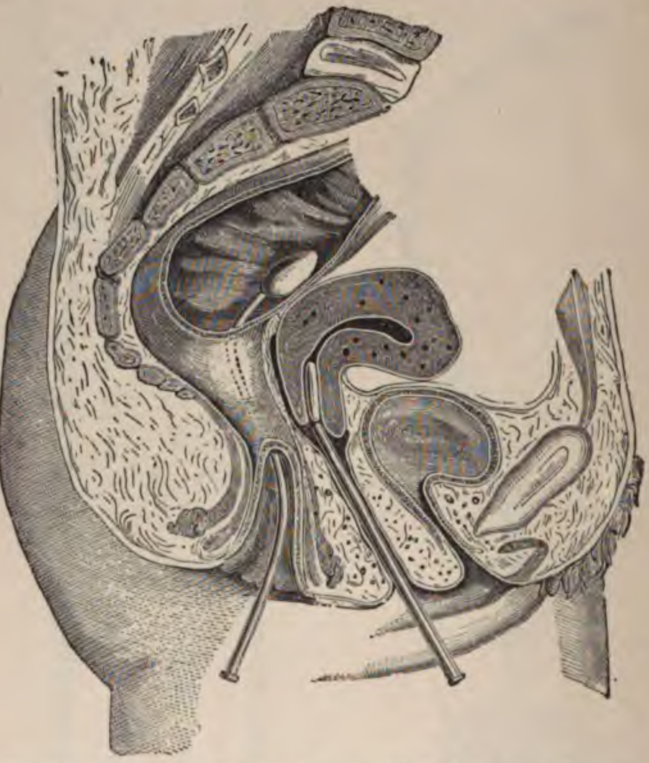


Fig. 89.—Tripier's Induction Current Method for Anteflexion.

In retroversion and retroflexion the anterior wall of the uterus must be acted upon and vesico-uterine induction current excitation employed (Fig. 90). The patient being in the dorsal position, the uterine exciter is first inserted, then the positive vesical, which is previously lubricated. After this the contacts are established and the apparatus put in action; the same hand then places the two probes in the required contact. The insertion of the vesical exciter is made like that of any ordinary probe; the pavilion (handle) must be raised at the time of operating, but only at that time, so as to lean the active tips on the anterior wall of the uterus.

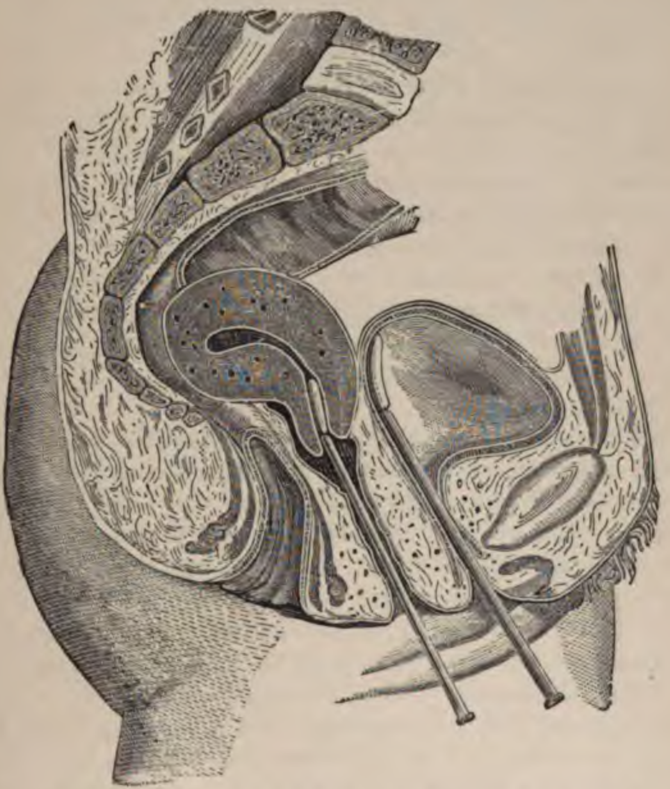


Fig. 90.—Tripier's Method of Induction Current Treatment for Retroflexion.

The application should not last longer than three minutes, to avoid fatiguing the muscular structures.

CHAPTER XIX.

RELAXATION AND FUNCTIONAL INCAPACITY OF THE ABDOMINAL WALLS AND VISCERA.

IN the remarks on the general examination and classification of cases, on page 10, emphasis was laid on the necessity for distinguishing between pelvic affections and those that have their origin in relaxations and displacements of the abdominal viscera. These latter affections are almost peculiar to women, owing to the frequency with which their causation may be traced to the combined effects of corset-wearing, pregnancy, and sedentary habits. A few words on their clinical aspects are most necessary in a treatise on the conservative treatment of the diseases of women, and particularly in this work, owing to the unique value of a certain combination of electric currents in their alleviation.

Few women pass through one or more pregnancies without a residual weakening of the abdominal walls, which, if uncorrected, remains a menace to their intra-abdominal tone in after-years. No one can believe for a moment that this abdominal laxity and protrusion is a necessary sequence of pregnancy, and there can be no doubt that it owes its presence to the pestilential corset imposed upon occidental women by a barbarous whim of our civilization. And do not let us be self-deceived on this point. I do not refer at all to tight lacing and its horrible results on the abdominal viscera, but to the so-called loose-fitting corset of most comfortable shape, whose harmful effect is due to two factors: 1. It supplements the natural body-wall of the abdomen by an artificial, external skeletal support never intended by nature, resulting in atrophy and weakening of the abdominal muscles, the natural support of the body-wall at this point. 2. During and after the first pregnancy this artificial skeleton, which had heretofore been a moderately equable support to all of the muscles of the abdomen, is efficient in the upper portion only, leaving about one-half unsupported in this way, and resulting in a removal of pressure and consequent protrusion of the lower half of the abdomen. This leads directly to either partial or general enteroptosis, or displacement of the hollow viscera, and—if there is a tendency to fatty degeneration of the organs—to morbid dilatations also.[1]

The dragging sensations and backache thus produced are frequently mistaken for pelvic disease, though often not associated with any abnormality in that cavity. Constipation due to an enlarged and sacculated colon is invariably present; and, when the organs exhibit also a weakened musculation owing to fatty degeneration of their unstriated muscular coats, we may have profound effects on the general health from absorption of toxins and deficient secretion of the glandular organs. An arhythmic heart action even may be traced to this condition.

The most effective treatment known to the author consists in labile applications of electric currents to the weakened and dilated organs of a strength that will induce contraction, as well as profoundly stimulate glandular action. Such currents must be from 100 to 150 milliampères, which I believe is much more than has heretofore been given in this way, and should be simultaneously combined with the most powerful primary induction currents, applied from an active pad on the abdomen to the large indifferent pad on which the patient lies, as shown in Plate V, the movements given to the anterior soaped pad resulting in a form of abdominal electro-massage of great service. In addition to following the direction of the colon in these movements, the active pad should be passed down the flanks on each side, just above the pelvic bones, to further reach the motor points of the abdominal muscles.

The powerful currents advised are by no means limited in effect to the abdominal muscles, but constitute also a stimulus to the contraction of the dilated intestines, gradually adding tone by the regeneration of muscular fiber. The constant current in this dose can also be relied on to stimulate the secretory and excretory organs of the abdomen, resulting in relief of constipation, general improvement in blood-conditions, and disappearance of irregularities in heart action. In one case recently under treatment an improvement in the rhythm of the heart could be detected after each application, probably due to direct stimulation of the sympathetic nerves in the epigastric region.

---

[1] It should be said, however, in modification of the above remarks, that the "straight-front" corset of recent adoption produces far less trouble than the older varieties, and, when put on properly, is often a valuable support to the abdomen.

In pronounced cases of abdominal relaxation it will be wise to hasten relief by prescribing a suitable abdominal supporter at once, which may be discarded later as improvement progresses.

Massage is a most valuable remedy in these conditions also. The following extract concerning its indications and contra-indications is taken from the recently published work by Boardman Reed, M.D.[1]

"**Indications for Massage of the Abdomen.**—It may be well here to summarize in tabular form the conditions under which massage of the abdomen has been found in my experience particularly useful:—

"1. Chronic gastritis in all its forms excepting those accompanied by hyperchlorhydria.

"2. Anacidity or subacidity, except when dependent upon acute gastritis, carcinoma, or, though this does not often coexist, ulcer.

"3. Gastrectasis not dependent on or associated with cancer or ulcer.

"4. Atonic conditions of the stomach walls, whether progressed to the stage of dilatation or not.

"5. Displacements of the various abdominal organs, including
  (a) Gastroptosis.
  (b) Nephroptosis, except in cases in which the displaced kidney has become excessively tender on pressure, and always with care to avoid manipulating the movable kidney.
  (c) Enteroptosis.
  (d) Hepatoptosis.

"6. Chronic intestinal catarrh, not complicated by deep ulceration.

"7. Dilatation of the intestines.

"8. Chronic catarrhal appendicitis.

"9. Constipation from unknown causes with the exception that deep or vigorous kneading may aggravate the spastic forms and those resulting from stricture or other serious obstruction. In many cases massage alone cures.

"10. In a group of symptoms which comprise especially tenderness, over a region three or four inches in diameter, including the umbilicus as its center, and a marked pulsation of the abdominal aorta in the entire epigastric region. These symptoms have been assumed, with how much truth I am not prepared to say, to denote congestion or irritation of the solar plexus or of one or more of the other plexuses of the abdominal sympathetic. They are often met with in practice and may be the result of auto-infection from the gastro-intestinal tract. My experience shows that these symptoms are usually benefited by gentle kneading of the abdomen in connection with careful attention to diet.

---

[1] "Diseases of the Stomach and Intestines," by Boardman Reed, M.D. E. B. Treat & Co., New York, 1904.

"**Contra-indications for Massage of the Abdomen.**—The following are the principal ones:—

"1. Ulceration in any part of the stomach or intestines.

"2. Cancer of any of the abdominal organs.

"3. Acute inflammation of any abdominal or pelvic organ.

"4. Hyperchlorhydria, acid gastritis, or, indeed, any of the forms of excessive secretion of the gastric juice.

"5. Prolapsed kidneys which are sensitive to palpation.

"6. Aneurism of any of the abdominal or thoracic arteries.

"7. During the menstrual period, when the flow is excessive or when there is a tendency to menorrhagia.

"8. In fatty degeneration or marked dilatation of the heart and advanced phthisis, especially with a tendency to hemoptysis, abdominal massage should be practiced—if at all—with much care and gentleness.

"In addition to the foregoing, Boas, on the authority of Dr. Zabludowski (a well-known *masseur* and writer on massage in Berlin), mentions, as another contra-indication, a tense condition or kind of tetanic contraction of the recti muscles, which is so often seen in cases of neurasthenia. In such cases Zabludowski advises 'hands off.' Zabludowski's method (as I happen to know from personal experience of it, when in Berlin in 1895) is one in which tapotement and a peculiar mixture of violent slapping and vigorous kneading predominate. These procedures would be harmful, of course, under the conditions above referred to, but the gentle stroking and kneading which are given to such patients, under my personal direction, have been found uniformly helpful and curative to the underlying disease, and at the same time soothing to the overtense muscles."

CHAPTER XX.

MATERNAL STERILITY AND IMPOTENCE.

ASIDE from congenital deficiencies and anomalies of development of the essential organs of generation, we have been taught, since the days of Marion Sims, that the chief reason for sterility attributable to the woman is narrowness or flexion of the uterine canal. When it is remembered that the narrowest pin-hole os will admit a sound, on careful manipulation, which is many times larger than the self-propelling spermatozoöid, it would seem that this reasoning is inconclusive. It is doubtless to the operative *furor* that the popularity of the stenosis-and-atresia theory of sterility is due, for, since the days of Sims and J. Y. Simpson, practically no form of treatment has been employed except some method of enlargement of the canal. This was at first accomplished by slitting the cervix, producing artificially, in other words, the same lesion for the sewing up of which other costly operations were later devised. Owing to the combined ineffectiveness, morbidity, and mortality of this procedure, it has, of late, been superseded by so-called "dilatation," which is accomplished only by tearing apart the muscular and fibrous tissues that encircle the canal by powerful steel instruments. Only exceptionally has this accomplished a cure of the sterility, while it is, at times, followed by serious consequences in the shape of parametritis and diseased appendages. One case of ectopic pregnancy and a number of instances of uterine and ovarian tenderness have been observed by me after dilatation for this purpose in patients who were free from tenderness previously.

Far more prominent causes of sterility may be found in imperfect participation of the uterus in the sexual orgasm, catarrhal changes in the mucus of the uterus and tubes, and inactive ovaries,—the last two being the most important. A lessened aspiratory action of the uterus, while rendering conception less certain, cannot be a serious impediment, on account of the automobile powers of the spermatozoöids. This defect may, however, be materially lessened by the general intrapelvic action of electricity, promoting the nerve-tone of the organs, particularly of the uterus and ovaries, increasing muscular contractility, and quickening circulation. The method best adapted to accomplish this purpose is the vagino-abdominal constant current application with covered vaginal electrode, which should be negative, a current of 30 to 40 milliampères being turned on and off, gradually and repeatedly, by the swelling method. This may be supplemented with labile lumbar applications of the same current to the sexual center of the cord, the patient lying upon the face with a large pad under the abdomen.

Of the toxic effect of altered uterine secretions on the fertilizing cells of the semen there can be no question, and it is in these cases that the constant current applied within the cavity of the uterus is of the greatest service by its alterative action on the secreting surface. Unless the intra-uterine treatment is indicated, also, by marked changes in the mucous membrane, the covered elastic electrode is best as promoting favorable changes in the mucous membrane with least traumatism. It has been my habit to employ the positive pole usually, though the choice of pole for this purpose is open to further investigation to determine whether the normal alkalinity of the uterine mucus should be increased by the negative pole or diminished by the positive pole. Possibly neither effect is important, the results depending rather on the simple excitation of a more normal secretion.

Deficient activity of the ovaries can only be inferred as a cause of sterility in the absence of any demonstrable lesion or more patent defect of functionation on the part of the woman, and, of course, after the question of the possible sterility of the husband has been eliminated. It may or may not be associated with lack of sexual appetence and responsiveness, for many women conceive readily in whom the orgasm is deficient or absent. Any method of treatment that promotes increased activity of the pelvic circulation, such as negative vagino-abdominal applications of either current, may increase ovulation, while the musculo-tonic effect of the constant current turned on in the swelling manner repeatedly may do much to lessen a practical maternal impotence from weakened musculation, which is only less disastrous to the conjugal relation than similar conditions in the male.

But few instances of this affection have been placed under my care for the purpose of curing the sterility,—but five in all, in four of which the treatment was successful at some time during a year following the cessation of the treatment, two instances being almost immediate. In one case that was a failure up to the date of her last report to me the ovaries were both prolapsed and the tubes also probably involved in the remnants of an old pelvic inflammation. Her symptomatic condition was, nevertheless, improved.

The slight attention paid to this subject is doubtless due, in part, to a lack of information as to the value of this method and, in part, to the prevalent disinclination of American women for the burdens of maternity. That electricity may cure sterility when the patient only asks that the pelvic pain of uterine inflammation be cured is shown by the statement made on page 121, where, of 32 cases of uterine disease that involved at least temporary or acquired sterility, 8 had become pregnant after the treatment when my report was made to the American Electro-Therapeutic Association (September, 1894). In a paper by Apostoli read at the same meeting as many as 80 cases were recorded as having become pregnant after intra-uterine electric treatment, some of them having conceived shortly after one application. Apostoli does not mention how many of his cases were nulliparous after some years of marriage and, therefore, sterile, but of the 22 cases reported *in extenso* in the paper,[1] 5 were nulliparas. An interesting case of prolonged hemorrhagic metritis in a nullipara, the cure of which was followed by pregnancy, is detailed on page 107.

---

[1] "Transactions of the American Electro-Therapeutic Association," page 371, 1894.

CHAPTER XXI.

ECTOPIC GESTATION AND OBSTETRICS.

Ectopic Gestation.—This accident, which has been proven of late to be of considerable frequency both by the records of carefully conducted postmortem examinations and the experience of surgeons, is still probably even more frequent in occurrence, as many cases doubtless recover after extraperitoneal rupture without the diagnosis having been made.

It is beyond the scope of this work to enter into a full discussion of the etiology and natural history of ectopic gestation, since the value of electricity as a sole or principal remedy is confined to a certain stage of gestation only,—namely: from conception to the end of the fourth month, after which time the consideration of the affection belongs exclusively to the surgeon. During these early months, nevertheless, the electric treatment is clearly the method of choice, since it has been established by many competent observers that at this time the ovum may be devitalized and its complete absorption secured by this means, without subjecting the patient to the dangers and uncertainties of abdominal section.

Lawson Tait's classification of ectopic pregnancy, which is genererally received, is as follows:—

I. Ovarian—possible, but not proved.
II. Tubal, in free part of tube, is
    (a) Contained in tube up to fourteenth week, at or before which time primary rupture occurs, and then progress of gestation is directed into
    (b) Abdominal or intraperitoneal gestation; uniformly fatal (unless removed by abdominal section), primarily by hemorrhage, secondarily by suppuration of the sac and peritonitis.
    (c) Broad ligament or extraperitoneal, gestation, which
    (d) May develop in broad ligament to full term and be removed at viable period as living child.
    (e) May die and be absorbed as extraperitoneal hematocele.
    (f) May die and supurating ovum be discharged at or near umbilicus, or through vagina, bladder, or intestinal tract.
    (g) May remain quiescent as lithopedion.

(*h*) May become abdominal or intraperitoneal gestation by secondary rupture.

III. Tubo-ovarian, or interstitial, is contained in part of tube embraced by uterine tissue, and, so far as is known, is uniformly fatal, by primary intraperitoneal rupture (as *b*), before fifth month.

From this it will be seen that the question of electric treatment is concerned only with Class II *(a),* unruptured tubal pregnancy before the fourteenth or sixteenth week, and with the same condition after early rupture into the broad ligament, where it continues to develop, as in II *(d).* Tubal pregnancy is, by far, the most frequent form, and its early diagnosis becomes, therefore, a matter of great importance, though attended with much difficulty. Indeed, the possibility of diagnosis before primary rupture of the sac into the broad ligament, which occurs at about the fourteenth week, has been denied by some authorities, yet a reasonably certain diagnosis has been made by both surgeons and electro-therapeutists in many instances of late, some of them of sufficient certainty to warrant the surgical removal in the absence of proper electric treatment and all of them certain enough to warrant the electric treatment, which would be equally applicable to most of the conditions for which it could be mistaken. And herein lies one of the two chief advantages of electricity at this stage of ectopic gestation. Given a reasonable presumption that the case is one of tubal or intraligamentous pregnancy, the physician is not compelled to take the horrible responsibility of counseling a possibly unnecessary unsexing operation in a young wife, but, with a full recognition of the possible gravity of the case, may subject her only to the discomforts of *absolute rest in bed* for one or more months, and daily applications of a method that will kill the fetus if one be present, and subsequently promote absorption of the ovum and surrounding congestion, and, if the case is not one of ectopic gestation, but a suddenly enlarged tube from inflammatory congestion, an ovaritis, or a small fibroid, will be equally effective in arresting progress and contributing to a future cure. The laudable object of verifying the diagnosis is secondary to the best interests of the patient, and in this case the patient's true interests point to the avoidance of the operation if the trouble can be cured without it, whether its true nature is ever proved or not.

The selection of electricity as the appropriate treatment is narrowed down, as before stated, to two stages in tubal pregnancy: (1) before rupture into broad ligament at or about the fourteenth week; (2) after rupture into broad ligament.

Diagnosis of Tubal Pregnancy Before Rupture.—Unfortunately, there are too often no symptoms to alarm the patient, or even to cause her to suspect pregnancy, until the onset of primary rupture of the sac into the tube, and this is not so surprising, when it is remembered that no small proportion of cases occur in those newly married, and therefore unfamiliar with the subjective symptoms of pregnancy, and in others who have been sterile so long as not to be looking for such a contingency. Such cases, moreover, are liable to have long felt some discomfort in the pelvis from latent catarrhal disease of the uterus or tubes, which is possibly an important etiologic factor in the arrest of the ovum in the tube. The symptoms at this stage, if any be noted, are likely to be those of a normal pregnancy, *usually accompanied by a continuance of or even more frequent and abundant menstruation.* More positive symptoms may, however, cause the patient to consult her physician, and these are the colicky paroxysms, attributed by Parry to contractions of the cyst. By others they have been attributed to minute hemorrhages. More likely they are merely the neuralgic expression of an unaccustomed and growing tension of the tube, the universal habit of sensory nerves being the explosive expression of a continuous tension or irritation. While the habit of examining all women in the early months of even supposedly normal pregnancy should be aimed at as a routine measure, the physician should invariably make an examination by touch when pain of this nature is complained of.

On bimanual examination, which, in a suspected case, should be as gently conducted as is consistent with a thorough mapping out of the pelvic contents, a soft, elastic, semifluctuating tumor will be found in the region of the tube, on one or other side of the fundus, corresponding, in size, to the development of the ovum. This mass is quite evidently cystic to the educated touch and is usually more tender than any other cystic tumor with which it can be confounded. The cervix will present the softening peculiar to pregnancy, but the uterus will be found to be smaller than it should be at a corresponding period of normal pregnancy.

Such are the presumptive signs of a tubal pregnancy prior to rupture. Though abdominal sections have been performed on the strength of diagnoses so arrived at, and the condition at times verified, there is grave reason to doubt that the diagnosis can be sufficiently certain before operation to warrant so extreme a measure. Indeed, cases have been recently reported where the finding of slight traces of bloody serum near the tube was accepted by the operator as justifying the operation, even when no other evidence of the ovum could be found. Fortunately, these views were combated at a meeting of the New York Obstetrical Society by Dr. A. Palmer Dudley,[1] who explained that similar conditions had been found by him in operations during menstruation in the absence of any kind of pregnancy. The gravity of the conclusions that lead a surgeon to perform a dangerous operation resulting inevitably in castration on a young wife of a few weeks or months is by no means slight, and when this grave risk and abhorrent results are deliberately preferred to electric treatment, with the abundant testimony in its favor at this stage of the disease, the conduct of the surgeon should meet with condemnation by all thoughtful physicians. And this may even be said of a case where the presumptive evidence of an unruptured tubal pregnancy is very strong, as there is, at this stage, no reason whatever why complete absorption should not follow electric feticide, permitting the tube even, and surely the ovary, to be subsequently brought into a healthy condition under vaginal applications.

There is, on the contrary, no contra-indication to electricity whether the diagnosis be certain or uncertain. If it is a case of tubal pregnancy it may be cured in this way. If it be not, no harm is done by the treatment, which may even be equally adapted to the actual diseases present, such as a salpingitis with exudation, or a nonpurulent enlargement of the ovary. Both of these conditions are, in fact, relieved with such certainty by vagino-abdominal constant and induced currents as frequently to leave the physician in doubt as to the true nature of the disease; but surely no sane woman would wish an abdominal section to satisfy a scientific inquiry of no concern to her. Diagnostic uncertainty can surely be borne in connection with the advantage of restored health, plus the retention of important functions, when wisdom is purchased at such a cost.

---

[1] New York Gynecological and Obstetrical Journal, page 109, July, 1896.

Diagnosis of Tubal Pregnancy At and After Rupture.—After rupture of the sac has occurred the diagnosis is far easier to make than before. A sharp, agonizing pain in the pelvis, accompanied by more or less collapse,—anxious expression, fainting, cold and pallid skin bedewed with a cold perspiration, and a rapid and feeble pulse, becoming imperceptible,—betokens a rupture into the peritoneal cavity if an antecedent history of presumptive pregnancy can be obtained and the pelvic examination coincides. The physical signs of intraperitoneal rupture obtainable by touch are not so well marked as when the rupture is into the broad ligament. The mass at one side of the uterus is boggy and usually less in size than previous to rupture. When the rupture is into the broad ligament a tense, exceedingly painful tumor is found on one side of the uterus, usually pressing the latter to the opposite side of the pelvis.

To determine whether the case is suitable for electricity or must be at once consigned to surgery it is important to distinguish between a rupture into the peritoneal cavity or into the broad ligament. The former produces the more profound shock and collapse, and on vaginal examination a less prominent tumor is found. The latter is accompanied by less shock and presents a more rounded, tense, and prominent tumor. In either case a flow from the uterus may exist, simulating abortion, from which it is to be distinguished by the smaller size of the uterus, the possibility of, at times, making out a sulcus between the tumor and the fundus, and finally by finding the uterus empty should it be thought necessary to sound it. Additional causes of error are confounding it with rupture of another viscus, hematocele or hematoma from other causes, or a violent attack of hysteria.

Should the condition of the patient indicate that the hæmorrhage is into the abdominal cavity instead of merely within the layers of the broad ligament no time should be lost in having the abdomen opened and the bleeding points tied by a competent abdominal surgeon. The whole question of the use of electricity before the fourth month hinges, therefore, on the presence of free bleeding into the abdomen. After the fourth month electricity cannot be said to have a curative place in the treatment.

Electric Treatment.—As before remarked, the purposes of the electric treatment are twofold: to kill the fetus and to cause its absorption. To accomplish the former powerful currents are required, which should always be turned on gradually with the controller, and in the case of the constant current it is best to employ polar alternatives, the internal electrode being alternately positive and negative. The current should be turned on gradually, held for two minutes, turned off gradually, the polarity reversed without removing the electrode, and the procedure repeated with the current in the opposite direction. The ordinary vagino-abdominal method (page 67) is employed, a cotton-covered vaginal electrode being pressed against the tumor in the vagina, with a large, moist, clay pad or other efficient dispersing electrode on the abdomen. Induced currents, which should preferably be the primary of a powerful coil, are thought to be best by some, and it is therefore wisest to use both currents, one after the other, at least once daily until the sac shrinks and becomes less tender. The same treatment should then be continued at greater intervals and less dosage until absorption seems well under way.

The constant current dosage should be from 100 to 150 milliampères and the induction to the point of endurance, all possibility of shocks being eliminated, particularly if rupture into the broad ligament has occurred.

Dr. A. Brothers, of New York, has made a careful statistical study of the cases reported in medical literature, and his paper[1] on the subject deserves to be quoted in full as presented to the American Electro-Therapeutic Association in September, 1893:—

> First employed in Italy by Bachetti in 1853, and later by Braxton Hicks in England in 1866, the electric method of treating ectopic gestation was first resorted to on this side of the Atlantic by Allen, of Philadelphia, in 1869, and has since remained almost a purely American plan of treatment. In the paper which I wrote, five years ago, for *The American Journal of Obstetrics* (May, 1888) I collected statistics of 43 cases treated by electricity, with 1 death. In a paper published two years later, on the "Subsequent Behavior of Cases Treated by Electricity,"[2] I found that the 25 cases which I had been able to trace were doing well after a lapse of from one to eight years, and that none of them had been compelled to undergo secondary operations. Many of these patients still carried traces of the old trouble, but without perceptible inconvenience.

---

[1] "Present Position of the Electric Treatment of Extra-uterine Pregnancy," "Transactions of the American Electro-Therapeutic Association," page 170, 1893.

[2] The American Journal of Obstetrics, 1890, Volume xxiii, page 113.

Within the last few years the epidemic of laparotomy fever which originated in Europe has infected our shores and spread over our continent to such an extent as temporarily to displace this treatment from the position it properly deserves. As a result, the literature of the past few years shows a smaller number of cases published than we should expect from the past success of this treatment, although a small band of able practitioners continue to adhere to their convictions and employ it, under judicious restrictions, wherever it is properly indicated.

To bring this subject down to the present I have reviewed the literature at my command, and am thus enabled to present the table on pages 284 and 285.

I have therefore been able to find records of 85 cases of extra-uterine pregnancy in which electricity was employed to destroy the fetus. I do not regard this as a complete list, for some cases have been overlooked and others have not been published. It is sufficient, however, to show that the method has been pretty extensively employed.

In 2 cases (Nos. 60 and 61) the treatment apparently failed in the hands of very able men (Coe and Wenning), but subsequent laparotomy showed the diagnosis to have been faulty, for in both cases the gestation was intrauterine. Coe saved his patient after she aborted, but Wenning, who had resorted also to aspiration, was unfortunate in losing his. In Case 81, that of Lewis, electricity was discarded and abdominal section performed, resulting in recovery.[1] In one of Blackwood's cases the extra-uterine mass had shrunk two years later to one-half its original size, and he was in favor of galvanism to further its absorption. The patient, however, was advised by a specialist to submit to laparotomy, from which she died. In none of these cases can the electric treatment be accused of having done any harm.

Collapse during the administration of the current has occurred in the cases of Mundé (23), Janvrin (34), and Coe (54); but only 1 case—that of Janvrin (34)—proved fatal. In 2 of Blackwood's cases (70 and 71) the symptoms of internal hemorrhage due to partial rupture—shock, faintness, debility, etc.,—were present, but the doctor writes me that the cases made favorable recoveries.

Aspiration was resorted to in 3 cases in connection with electricity by Braxton Hicks (2), Lusk (30), and Wenning (61). Hicks and Wenning lost their patients,—the latter supplementing the procedure by laparotomy,—but Lusk saved his case after assisting the discharge of the fetus through a vaginal rent.

The fetus was displaced from the tube into the uterine cavity in 5 cases,—those of McBurney (6), Garrigues (29), Blackwood (74), Grandin (83), and Carriker (84).

---

[1] The cause for discarding electricity in Lewis's patient was a fear that the case was a normal pregnancy. There was no need of the subsequent laparotomy, as absorption of the fetus was partially complete.—G. B. M.

TABLE OF CASES OF EXTRA-UTERINE PREGNANCY TREATED BY ELECTRICITY.

No.	Case of	Reported in	Current.	Nationality.	Result.	Remarks.
1.	Bachetti	Trans. Am. Gyn. Soc., 1882	Electro-puncture	Italy	Recovery.	
2.	Hicks	Trans. Am. Gyn. Soc., 1882	Faradism.	England	Death.	Puncture later caused death.
3.	Allen	Trans. Am. Gyn. Soc., 1882	Faradism.	U. S.	Recovery.	
4	Allen	Am. Jour. of Obst., 1872, vol. v	Faradism.	U. S.	Recovery.	
5.	Landis	Ohio Med. and Surg. Jour., Oct., 1877	Faradism.	U. S.	Recovery.	
6.	McBurney	N. Y. Med. Jour., March, 1878.	Galvanism	U. S.	Recovery.	Fetus discharged through vagina.
7.	Reeve	Trans. Am. Gyn. Soc., 1879	Faradism.	U. S.	Recovery.	
8.	Harrison	Trans. Am. Gyn. Soc., 1882	Faradism.	U. S.	Recovery.	
9.	Lusk	Am. Jour. of Obst., April, 1881	Faradism.	U. S.	Recovery.	
10.	Wilson	Trans. Am. Gyn. Soc., 1882	Faradism.	U. S.	Recovery.	
11.	Landis	Med. News, August 8, 1882	Faradism.	U. S.	Recovery.	Same case as No. 5.
12.	Billington	Trans. Am. Gyn. Soc., 1882	Galvanism	U. S.	Recovery.	
13.	Emmet	Am. Jour. of Obst., Feb., 1882	Galvanism	U. S.	Recovery.	
14.	Garrigues	Am. Jour. of Obst., Sept., 1882	Faradism.	U. S.	Recovery.	
15.	Herrick	Trans. Am. Gyn. Soc., 1882	Galvanism	U. S.	Recovery.	
16.	Hochmann	Allg. med. Centrztg., April, 1883	Static electricity	Germany	Recovery.	
17.	Westcott	Beard and Rockwell's "Electricity"	Galvanism	U. S.	Recovery.	Normal pregnancy not disturbed.
18.	Rockwell	Beard and Rockwell's "Electricity"	Galvanism	U. S.	Recovery.	
19.	Sims	Beard and Rockwell's "Electricity"	Galvanism	U. S.	Recovery.	
20.	Cushier	Trans. Am. Gyn. Soc., 1884	Faradism.	U. S.	Recovery.	
21.	Cocks	Trans. Am. Gyn. Soc., 1884	Faradism, later galvanism	U. S.	Recovery.	
22.	Lambert	Trans. Am. Gyn. Soc., 1884	Galvanism	U. S.	Recovery.	
23.	Mundé	Am. Jour. of Obst., Oct., 1884	Galvanism, later faradism	U. S.	Recovery.	Collapse after first application.
24.	Berlin	Bost. Med. and Surg. Jour., Sept., 1884	Galvanism	U. S.	Recovery.	
25.	Sibbald	Polyclinic, 1884. No. 15	Galvanism	U. S.	Recovery.	
26.	Briggs	Med. News, July 11, 1885	Faradism.	U. S.	Recovery.	
27.	Stoddard	Med. News, July 11, 1885	Faradism.	U. S.	Recovery.	
28.	Lusk	Am. Jour. of Obst., Aug., 1885	Faradism.	U. S.	Recovery.	
29.	Garrigues	Med. News, Dec. 12. 1885	Faradism.	U. S.	Recovery.	Fetus expelled into uterine cavity.
30.	Lusk	Med. Rec., Jan. 23, 1886	Faradism.	U. S.	Recovery.	Also puncture. Fetus removed through vaginal rent.
31.	Goelet	Med. Rec., June 26, 1886	Galvanism	U. S.	Recovery.	
32.	Aveling	Br. Med. Jour., Dec. 4, 1886	Faradism.	England	Recovery.	
33.	Gardner	Br. Med. Jour., Dec. 4, 1886	Faradism.	Canada	Recovery.	
34.	Janvrin	Trans. Am. Gyn. Soc., 1886	Galvanism	U. S.	Death	Fatal result after third application.
35.	Petch	Br. Med. Jour., Dec. 4, 1886	Galvano-puncture	England	Recovery.	
36.	Trush	Am. Jour. of Obst., Dec., 1886	Faradism.	U. S.	Recovery.	
37.	Van de Warker	Trans. Am. Gyn. Soc., 1887	Faradism.	U. S.	Recovery.	
38.	Sims	Annals of Gyn., Jan., 1888	Galvanism	U. S.	Recovery.	
39.	Chadwick	Trans. Am. Gyn. Soc., 1887	Galvanism	U. S.	Recovery.	Fetus extracted through vaginal rent.
40.	Mann	Med. News, July 11, 1885	(?)	U. S.	Recovery.	
41.	Page	Am. Jour. of Obst., April, 1887	Galvanism	U. S.	Recovery.	
42.	Harrison	Am. Jour. of Obst., April, 1887	Galvanism	U. S.	Recovery.	
43.	Brothers	Am. Jour. of Obst., May, 1888	Faradism.	U. S.	Recovery.	

TABLE OF CASES OF EXTRA-UTERINE PREGNANCY TREATED BY ELECTRICITY (*concluded*).

No.	Case of	Reported in	Current.	Nationality.	Result.	Remarks.
44.	Taylor	Med. Rec., June 29, 1889	Galvanism	U. S.	Recovery.	
45.	Walker	Med. Rec., Nov. 16, 1889	Faradism	U. S.	Recovery.	
46.	Galabin	Arch. de Tocol., xvi, 1889	Galvano-puncture	France	Recovery.	
47.	Kletzsch	Am. Jour. of Obst., 1888, xxi	Faradism	U. S. (?)	Recovery.	
48.	Buckmaster	Med. News, 1888, liii	Galvanism	U. S. (?)	Recovery.	
49.	Duncan and Steavenson	Br. Gyn. Jour., 1888	Faradism, later galvano-puncture	England	Death.	
50.	Bolton and Steavenson	Br. Gyn. Jour., 1888	Electro-puncture	England	Death.	
51.	Benton	Gaillard's Med. Jour., 1888	Faradism	U. S.	Recovery.	
52.	Bierwirth	Gaillard's Med. Jour., 1888	Faradism	U. S.	Recovery.	Complicating typhoid fever.
53.	Edebohls	Med. Rec., Dec. 7, 1889	Faradism	U. S.	Recovery.	
54.	Coe	Am. Jour. of Obst., 1890	Faradism	U. S.	Recovery.	Sac ruptured. No laparotomy required.
55 56 57	Hanks	Am. Jour. of Obst., 1890	Faradism (?)	U. S.	Recovery.	
58 59	McLean	Am. Jour. of Obst., 1890	Faradism (?)	U. S.	Recovery.	
60.	Coe	Am. Jour. of Obst., 1890	Faradism	U. S.	Recovery.	Laparotomy showed normal pregnancy.
61.	Wenning	Am. Jour. of Obst., 1890	Faradism, later galvanism	U. S.	Death	Aspiration later, then laparotomy; dextro-torsion of uterus found.
62.	Blackwood	Correspondence	Faradism, later galvanism	U. S.	Death	Laparotomy done two years later with fatal result.
63.	Blackwood	Correspondence	Faradism, later galvanism	U. S.	Recovery.	Previous rupture of sac.
64.	Blackwood	Correspondence	Faradism, later galvanism	U. S.	Recovery.	Previous rupture of sac.
65.	Blackwood	Correspondence	Faradism, later galvanism	U. S.	Recovery.	*Débris* discharged through rectum.
66.	Blackwood	Correspondence	Faradism, later galvanism	U. S.	Recovery.	*Débris* discharged through vagina.
67.	Blackwood	Correspondence	Faradism, later galvanism	U. S.	Recovery.	Fetus expelled into uterus.
to 74.	Blackwood	Correspondence	Faradism, later galvanism	U. S.	Recovery.	
75.	Smouse	Trans. Iowa Med. Soc., 1890	Galvanism (?)	U. S.	Recovery.	
76.	Martin	Austr. Med. Gaz., vol. ix	Faradism	Australia	Recovery.	
77.	Nedswetsky	Ann. de gyn. et d'ob., 1890, xxxiii	Galvanism	Russia	Recovery.	
78.	Nedswetsky	Ann. de gyn. et d'ob., 1890, xxxiii	Galvanism	Russia	Recovery.	
79	Warnek	Ann. de gyn. et d'ob., 1890, xxxiii	Electro-puncture	Russia	Recovery.	
80.	Kalabine	Ann. de gyn. et d'ob., 1890, xxxiii	Galvanism, later electro-puncture	Russia	Recovery.	
81.	Lewis	Trans. Col. Phys. Phila., 1891	Faradism (?)	U. S.	Recovery.	Electricity discarded and laparotomy performed.
82.	St. John	Jour. Am. Med. Assoc., 1892	Galvanism	U. S.	Recovery.	
83.	Grandin & Cole	N. Y. Jour. Gyn. and Obst., 1892	Galvanism	U. S.	Recovery.	Fetus expelled into uterus.
84.	Carriker	Eclect. Med. Jour., 1892	Galvanism	U. S.	Recovery.	Fetus expelled through vagina.
85.	Nedoroloff	Index Medicus, 1892	Galvanism	Russia	Recovery.	

The case of Landis (5 and 11) is unique in that the same patient suffered twice from extra-uterine pregnancy, but was in each instance successfully treated by electricity.

In Westcott's case (17) the extra-uterine pregnancy was associated with normal pregnancy, which was not disturbed by the treatment, and Bierwirth's patient (52) was suffering from typhoid fever while undergoing the same treatment.

The fetus was expelled through vaginal or rectal rents in 4 cases,—those of Lusk (30), Chadwick (39), and Blackwood (72 and 73). These patients ultimately recovered.

Only 1 death—that of Janvrin's patient (34)—has occurred in 78 cases in which electricity was employed without puncture, and in this case there were marked symptoms of hemorrhage previous to the resort to electricity.

The nature of the current used has varied. In 27 cases the induction current was used, in 25 cases the constant, either current (not stated) in 9 cases, both currents successfully in 16 cases, galvano-puncture in 7 cases and static electricity in 1 case.

Of the 7 cases treated by electro-puncture, there were 5 recoveries and 2 deaths. This proves electro-puncture to be a very dangerous method, the bad results being undoubtedly due to the puncture and not to the current. Similar bad results have followed the use of simple puncture with aspiration or followed by the injection of drugs. In my first paper I referred to 14 cases of failure or death after the use of simple tapping or injection of drugs.

Although the electric treatment has been chiefly employed in our own country, my table shows the interesting fact that it has also been used 5 times in Russia, 5 times in England, and 1 time in Italy, Canada, Germany, France, and Australia.

It may be interesting to quote, at this point, the most recent views of many of the best authorities regarding this plan of treament. Playfair[1] says: "This practice is perfectly safe, and there can be no rational objection to its being tried." Lusk[2] says: "The danger which threatens the life of the patient is often imminent, and assistance from afar is not always easy to obtain. Under these conditions the indication for treatment is plainly the adoption of measures to destroy the life of the fetus, and thus, by arresting the growth of the ovum, to diminish the chances of rupture and hemorrhage." In a personal interview with Professor Lusk he stated that he was as much interested in the electric treatment as ever, but lately had met cases in which hemorrhage had already occurred and which required operative interference. He was perfectly convinced of the efficacy of electric treatment in suitable cases, and was perfectly sure that in the cases in which he had successfully resorted to it there was no possibility of a mistake in diagnosis.

Prof. T. G. Thomas, early in the summer (of 1893), also stated that he was as firm a believer in the treatment of these cases by electricity as ever.

---

[1] "A treatise on the Science and Practice of Midwifery," London, 1889.

[2] "The Science and Art of Midwifery," New York, 1892.

In Thomas and Mundé on "Diseases of Women" (Philadelphia, 1891) it is stated: "At one extreme stand able and conservative practitioners, who appear to favor the position that, as a very general rule, we should stand calmly by with folded arms and accept without effort or resistance the terrible chances of death which attend these cases. At the other we see enthusiastic ones, with strong surgical proclivities, who would apparently resort to laparotomy in every case in which diagnosis is possible. On a middle ground, one lying between these extremes, the truly conservative surgeon will find his appropriate position."

Although Pozzi in his "Treatise on Gynecology" (American edition, 1892) condemns the use of electricity, the able editor of this work (B. H. Wells), quoting Byford, says: "If we have a case of extra-uterine pregnancy in the early months it is safe to destroy the fetus by electricity and keep the patient in bed until absorption has noticeably commenced. If profuse, repeated hemorrhages occur, it is safer to operate at once."

Parvin[1] says: "Throwing aside all doubtful cases, there remains a strong argument from actual experience in favor of the treatment of ectopic gestation, prior to the rupture of the fetal cyst, by electricity."

The works on electricity in its relation to gynecology by A. H. Goelet[2] and Grandin and Gunning[3] are likewise strongly in favor of the employment of electricity in the treatment of early cases of ectopic gestation. Byford, Mann, Skene, Wilson, and many other eminent specialists in gynecology have also in recent times expressed themselves in favor of this plan of treatment.

The Boston Medical Society, at its meeting held on November 12, 1892, received the report of the chairman of a committee appointed to investigate the present condition of medical opinion with regard to the subject of extra-uterine pregnancy.[4] The report reads: "Immediate celiotomy, so soon as the diagnosis is established, is then, in the judgment of your committee, the only treatment which should be considered before rupture of the tube." If the gentlemen of this committee can spare the time to review the facts gathered in this paper, they may charitably allow a small place, at least, for the treatment of some of these cases by electricity. The fact is, in spite of the highly moral position taken by Lawson Tait, that feticide in extra-uterine pregnancy is considered justifiable in the interests of the mother by a great many practitioners. It is also a fact, which this paper proves, that, beyond 1 death in 78 cases, no injury has ever been done by the use of electricity, and where it has been directly abandoned for laparotomy no harm was done by the previous treatment. The treatment has maintained its reputation for harmlessness; and although, in the eyes of some, it has been dubbed "ridiculous" and "cowardly" and the product of "ignorant obstinacy," it continues to assert itself as a simple, innocent procedure which has its own proper sphere of usefulness.

---

[1] "Science and Art of Obstetrics," Philadelphia, 1890.

[2] "The Electro-therapeutics of Gynecology," Detroit, 1892.

[3] "Practical Treatise on Electricity in Gynecology," New York, 1891.

[4] E. Reynolds, Boston Medical and Surgical Journal, January, 1893, volume cxxviii, page 107.

Dr. Brothers's list is, in itself, sufficient to establish both the possibility of electric feticide and the advisability of its employment in the class of cases recommended in this chapter; but, when considering it as a record of the cases of this nature, we should remember that many other patients have been cured under vaginal electric applications which were possibly instances of extra-uterine pregnancy, but where diagnosis was too uncertain to permit them to be conscientiously reported as instances of this affection.

Abortion.—From what has been said in the preceding paragraphs it is evident that in electricity we have a feticide of positive and definite value which, when applied within the uterus, is certain to arrest the life of the embryo in those cases where a consultation determines the necessity for so terminating the pregnancy. The negative pole of the constant current is preferable, as it attracts moisture by anaphoresis and excites flow, the current-strength being from 30 to 75 milliampères, applied on a carefully asepticized sound-shaped electrode insulated beyond the internal os. Five minutes is a sufficient duration every other day for a week, when it will be found that the ovum is so reduced in size and detached as to readily pass away with but moderate uterine contraction. The first applications are best made with the elastic instrument (Fig. 32), even cotton-covered, as by this instrument the chances of puncturing the ovum are diminished and the likelihood of its entire expulsion increased. A few induction applications subsequently will hasten involution.

Hyperemesis Gravidarum.—Among the many useful remedies for the excessive nausea and vomiting of pregnancy none is more certain than the application of a fine-wire induction current to the solar plexus at the epigastric region. The anode should be placed at the back of the neck and the cathode, or negative pole, at the pit of the stomach, carefully avoiding the uterine region. The special value of this procedure, which is confined to fine-wire currents, is the direct sedation produced by it, though certain cases require instead that the sympathetic nerves in this situation should be stimulated by constant currents of from 15 to 30 milliampères applied from pads placed in the same position. Either of these procedures is likely to succeed in cases where everything else fails, rendering the induction of artificial abortion unnecessary.

Use of the Induction Current in Labor.—This is a subject of vast importance to the practicing obstetrician, for by this much neglected means a too slow labor may be hastened, atony of the uterus corrected, postpartum hemorrhage instantly controlled, and involution so hastened by a few, or at times only one, application, as to materially lessen the lying-in period.

Suggestions of this nature were made a number of years ago by Tripier, and more recently by Dr. W. T. Baird, of Texas, and Dr. R. J. Nunn, of Savannah, Ga.; yet, doubtless owing to the fact that the busy *accoucheur* has no battery with him in the lying-in chamber and if he sends to his office for it finds it out of order, but little use seems to have been made of these suggestions. Bearing in mind that it is the induction current only that is of service at this time, the remedy for this practical difficulty is the addition to the regular contents of the obstetric bag of a small Gaiffe battery (Fig. 91), which is inexpensive and always ready for use, for the solution employed is made instantly by the addition of a little water to a spoonful of the bisulphate of mercury carried in the battery-case. A more powerful coil is, at times, of greater service, but, as the principal obstetric uses of the induction current are due to its contractile

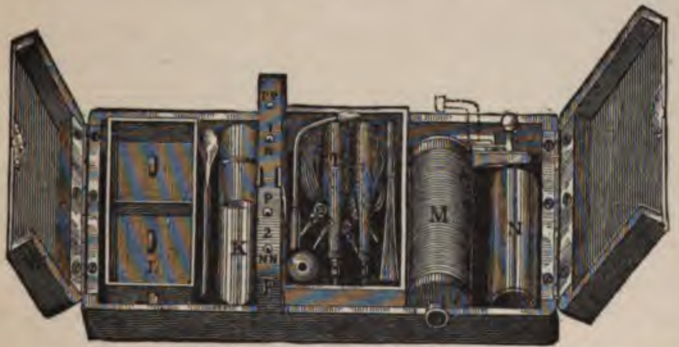


Fig. 91.—Gaiffe's Pocket Induction Battery. The exciting fluid is made in a few moments from bisulphate of mercury carried in a bottle *(K)* in a dry state, a spoonful of which is to be added to each of the cells *(L)*, water added, and the zincs replaced. Any cheap dry-cell induction battery is equally effective and convenient.

power, the primary coil of the Gaiffe battery should be employed and the resistance of the circuit diminished by having the external pole or poles increased in size by a folded towel well wetted with a solution of table salt. It should not be overlooked, also, that in all houses that are lighted by the Westinghouse alternating system (page 352), we have an excellent induction current at hand by simply unscrewing a lamp and placing a Massey or Jewell controller in circuit with the patient, when a current of any strength is obtainable by turning the crank to a point that gives perceptible results.

Inertia Uteri.—The contracting power of the induction current is not entirely barred by the presence of the child in the uterus, for, if the usual head presentation exists and inertia of the uterus occurs in spite of a well-dilated cervix, we may apply the electrodes (either ordinary disk-electrodes or, preferably, pads about the size of the palm of the hand) on either side of the fundus near the navel, and turn the current on forcibly at the inception of each pain, or about the time the pain should appear, turning it off at each intermission and repeating the procedure regularly for a time. This will not endanger the heart or respiration of the child, being too far from these vital organs, and will usually soon produce such vigorous contractions that the forceps may be left untouched while time is saved to the physician and much suffering saved to the patient. My own limited experience agrees with the statement of Dr. Baird, that the turning on of the current synchronously with the pains very materially lessens the suffering of the patient, even in normal labor, while at the same time the expulsive forces are re-enforced.

Postpartum Hemorrhage.—When this alarming accident is due to inertia of the uterus, which fails to contract properly and promptly after delivery of the placenta, there is nothing equal in immediate and thorough results to the primary or coarse-wire induction current applied with a bipolar electrode within the uterus or a single active pole in that situation and the other on the abdomen. The bipolar electrode (page 77) should be of the kind capable of thorough asepsis, preferably in the flame of the alcohol lamp, and the monopolar electrode should be blunt and properly insulated and asepticized. In an emergency where such instruments are inaccessible an intra-uterine electrode may be improvised for so large a cavity from a piece of wire about a yard long and a piece of rubber tubing a foot or eighteen inches long, in the following manner:—

Bare a considerable portion of the wire, if covered, and bend this end in a long loop; twist and fold the end of the loop into a ball that will project beyond the end of the rubber tube when it is passed through it, one end of the wire remaining within the tube and the other end being brought out at the opposite end of the tube and twisted around the tip of a conducting-cord, to make connection. The whole should now be immersed in boiling water for a few moments to insure cleanliness, after which the knobbed end may be inserted into the cavity and the instrument connected with one cord of the battery. The other electrode is placed on the abdomen and, if only an ordinary disk-electrode, may be increased in size by putting a folded napkin beneath it, well wetted with salt water. The induction current only is to be applied in this way.

Recent Subinvolution.—This subject has been treated of elsewhere (page 122), but it should be said, in this place, that subinvolution of the first or second month should be treated by the induction or alternating current, preferably bipolar, though monopolar intra-uterine applications of either of these currents will check hemorrhage, hasten involution, and not only permit a prompt getting-up, but avert later consequences in the shape of invitations to catarrhal invasions that so often supervene on this condition.

CHAPTER XXII.

BENIGN AFFECTIONS OF THE URETHRA, BLADDER, RECTUM, AND SIGMOID FLEXURE.

DISEASES OF THE URETHRA AND BLADDER.

Caruncle.—This little tumor of the urethral orifice, which often gives pain and discomfort out of all proportion to its size, may be eradicated by several electric methods, after it has been temporarily anesthetized by the cataphoric application of a cocaine solution. The cocaine should be applied on a cotton pledget saturated with the solution and held on the part by a carbon or platinum electrode, positive, with from 5 to 15 milliampères for some minutes, the negative indifferent pad being on the abdomen. If the growth is pedunculated the galvano-cautery loop may then be passed over it and the heat turned on as it is tightened. A sessile growth is best destroyed by negative puncture, followed, at the same sitting, by a small, positive zinc-amalgam electrode pressed into the opening thus made; from 10 to 15 milliampères will be sufficient.

Stricture or Ulcerations of the Urethra. — The treatment of strictures or ulcerations of the female urethra is as successfully accomplished as in the male and much more readily managed. The negative pole is, of course, necessarily the active one, as we wish a relaxing and softening effect, the electrode being the same as employed in the anterior urethra in males, having a straight shank with bulbs of different sizes. When not provided with these the physician may use the long-shanked zinc-amalgam electrodes designed for intra-uterine application (Fig. 33), the smallest size being usually appropriate. When the latter are used they are best lubricated by mercury, but not for cataphoresis, since the negative pole is imperatively necessary for dilatation, and, like all other electrodes to be inserted within the urethra, should be scrupulously cleaned, preferably fire-cleansed, before insertion. Four or 5 milliampères is a sufficient current-strength, the current being turned on when the stricture is reached, the operator gently pressing the instrument forward until it passes the contracted portion, then re-engaging it from behind. The procedure should be repeated every five to seven days until a cure is accomplished.

Ulcerations of the urethra are best treated (as ulcerations elsewhere) by positive zinc-amalgam cataphoresis, very small currents of 3 or 4 milliampères being sufficient.

Neuroses of the Urethra and Vulva.—Incontinence of urine in the adult may be corrected by a urethro-abdominal or urethro-sacral application of the primary induction current, turned on in the swelling method for from two to five minutes daily or every other day. In young girls or children the same results can be attained usually by external pubo-sacral applications of the same current with ordinary disk-electrodes.

The treatment of painful or pruriginous affections of the vulva, urethra, or bladder—such as *pruritus vulvæ, vaginismus,* etc.—is by no means so simple, though often yielding the best results. We must here search for an organic or constitutional basis for the symptoms, such as erosions, lithemia, toxemia, or kidney disease, to be corrected simultaneously with the appropriate local application. It needs scarcely to be said that we employ the high-tension induced current for a mere neurosis, having in view its anesthetic effect. If this be ineffective a weak solution of cocaine may be cataphorically driven in from a covered carbon electrode by a few milliampères, the active electrode being positive.

For neuralgia of any portion of the pelvis a vaginal bipolar induction current is usually effective with the high-tension coil.

Atony of the Bladder.—Contractile and tonic effects may be readily produced in the functionally weakened bladder by including the organ between the poles of a vagino-abdominal application of either current. A quickened micturition is, in fact, frequently noticed by patients undergoing this method for other purposes. In the paralysis from long distension, as in cases of chronic cystitis, particularly when fatty degeneration of the muscular coats of the organ is suspected, intravesical applications of the primary induction current should be made, and, if vesical irrigation of antiseptic fluids be practiced, the current should be applied simultaneously by the swelling method while the bladder is ejecting the liquid. This may be done by attaching a twisted-wire socket for connection with the battery to an ordinary silver catheter, insulating all but the tip with fused shellac, and employing it as an electrode. While the liquid is regurgitating the current will increase its force perceptibly, thus causing contraction of the bladder under the most favorable conditions. The irrigation is the only element of this application requiring special discrimination as to frequency, or producing possible reactions from overuse.

Cystoscopy.—In order that this subject may receive the most thorough and practical discussion, the author has requested Dr. Harris A. Slocum, Professor of Gynecology at the Philadelphia Polyclinic, to prepare a statement which will include the fruits of his wide experience in the examination of the bladder in women:—

Gynecologists have, for some time, recognized the close symptomatic relation of diseases of the uterus and its appendages with those of the bladder and such parts of the ureter and urethra as are in close proximity to it. This is probably due to the fact that the viscera of the pelvic cavity are supplied by the hypogastric plexus of the sympathetic, situated in front of the promontory of the sacrum, between the two common iliac arteries.

It may be noticed that the three principal pelvic organs in the female have a similar nerve-supply. The upper portions of the bladder, uterus, and rectum receive a nearly pure sympathetic distribution from the ovarian and inferior hypogastric plexuses of the sympathetic.

Their movements are unconsciously performed and entirely removed from the domination of the will, permitting, in the bladder and rectum, automatic adaption to varying amounts of contents, their retention during sleep, etc.; in a measure, this view also applies to the uterus when that organ is engaged in gestation, the sole object of its existence.

The outlets of these organs have a large proportion of insulated, spinal nerve-fibers. The sphincter ani receive filaments from the hemorrhoidal branch of the fourth sacral, the bladder and urethra being supplied from the third and fourth sacral, and the cervix the same. These introduce the elements of control or inhibition to the exit of each excretory organ (parturition is a modified excretion), more marked in the bladder and rectum, while evidently not at all volitional in the cervix.

The inhibitory function of the spinal element in the uterus is exerted, as before indicated, in the resistance offered by the cervix to the rhythmic contractions of the uterine muscle during gestation, and is probably the chief reason for their presence in that part of the organ.

It is the intimate relation of the nervous and vascular supply of the pelvic tissues that contributes mainly to their close symptomatic relationship, the rectum, as well as the bladder, frequently requiring investigation in seeking the cause for symptoms apparently uterine.

The purpose of this contribution is to give a brief description of the ordinary methods of examining the bladder as applied to office practice, and will not deal with diagnosis or treatment.

Two methods of investigation are available: the indirect and the direct. In the former the view of the bladder is obtained through Nitze and Leiter's cystoscope, which consists of an angled tube resembling a urethral sound, about twenty-one millimeters in circumference. The tip of the instrument contains a tiny electric light behind a window of quartz. At the recedent angle within the tube is a prism so placed that the rays received from the bladder-wall are reflected through a telescope to the eye of the examiner. After connecting the rheophores, contact is made and broken by means of a milled screw placed conveniently to the forefinger.

Several modifications of this instrument have been devised, among which may be mentioned that of Skene's, in which a ureteral catheter may be used and the ureters catheterized while under inspection.

In examining the bladder by this method, with the patient in the dorsal position, its interior is cleansed of mucus, pus, or blood if present, and filled with a warm, weak boric-acid solution, using a four-ounce glass or hard-rubber funnel, two feet of rubber tubing connected by a glass tube two inches in length with the catheter to be used. From four to eight ounces are necessary, according to the capacity of the bladder.

It requires a certain amount of experience with this instrument to obtain a correct impression of what is seen. The appearance of the area inspected varies with the distance of the prism from the bladder-wall. At 5 millimeters it is magnified to nearly twice the normal size; at 20 millimeters it is less than normal, while at 15 millimeters the view obtained about represents the true size of lesions as they exist. This distance is approximately secured by allowing the tip to touch the bladder-wall, and then withdrawing just sufficiently to clear it. Contact between instrument and bladder should otherwise be avoided, as the heat generated after three to five minutes' use is sufficient to burn painfully, and might give rise to a cystitis that had not previously existed.

Rather than continue a long, uninterrupted examination, it is far safer to shut off the current for half a minute after three to five minutes' use, and allow the instrument to cool.

The second, or direct method—described by Pawlik and Kelly—is far more satisfactory in examining the bladder in the female. The speculum is a straight, metallic tube nearly 10 centimeters in length, made in sizes of from 5 millimeters to 21 millimeters in diameter, with a flaring proximal extremity, a handle placed at an obtuse angle, and an obturator, snugly fitted, to facilitate introduction.

When necessary, the urethra is dilated with Kelly's steel urethral dilators or his calibrator: a spherically handled metallic cone 7.7 centimeters in length, 4 millimeters in diameter near the apex and 16 millimeters at the base, and graduated at each 2-millimeter increase in diameter. For office use or ordinary examination the 9-millimeter and 10-millimeter sizes are sufficient. The bladder-wall is easily examined through them, and they rarely require a preliminary dilatation.

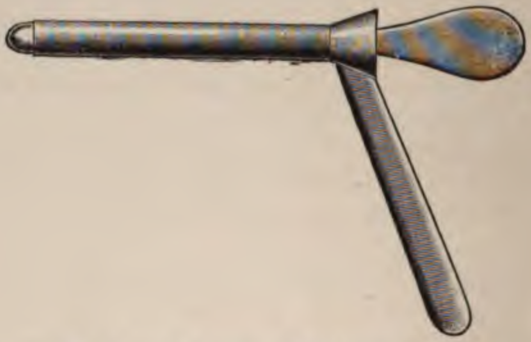


Fig. 92.—Cystoscope of J. Howard Kelly.

Other instruments required are: one or two urethral catheters, an aluminium applicator, and an appliance for removing accumulating urine.

One of three positions may be chosen in which to place the patient: Sims's position; the dorsal, with extreme elevation of the hips, and flexion of thighs and legs; and the knee-chest position. The latter is generally to be preferred; it is quickly attained and permits the maximum of expansion.

Corsets, bands, and all sources of constriction must be loosened, and the patient instructed to breathe freely and gently, not forcing the air from the lungs.

The bladder should be thoroughly emptied before introducing the speculum, and voluntary voiding generally clears it of all fluid.

After having observed the preliminary instructions regarding the clothing, the light from the head-mirror is thrown upon the urethral opening, and the speculum, warmed and oiled, is gently inserted in the meatus. Bear in mind the slight curve to the urethra, and begin the operation by having the handle slightly depressed and the beak pointing a degree upward. When it has penetrated for about an inch or an inch and a half, raise the handle half an inch to bring the instrument in the line of the canal and continue the introduction. If care and great gentleness are observed, the operation, in the majority of cases, with No. 6 speculum, is almost painless. The average time consumed is one and a half minutes. It must be done slowly, especially in office-work, where the patient at once goes from the house to the street.

Fig. 93.—Urethral Calibrator.

The greatest amount of resistance will be met just before the beak enters the bladder, and it is just here that the patient may first complain of pain. The amount of pressure used is hard to estimate, but is probably two ounces, and this, with an occasional rotary movement, is sufficient to allow of the insertion of the speculum into a bladder that is tender and irritable from chronic inflammation, with a minimum amount of pain at the time, and safety for the patient after she has left the office.

The examination may now be begun, bearing in mind that, in the majority of inflammatory cases, the lesions will be found on or near the floor of the bladder (the uppermost portion when in the genu-pectoral position). Two favorite spots where inflammatory areas are apt to be found are directly in the neck of the bladder (examined last, as the tube is being removed), and to either side of the neck. The latter can only be seen by carrying the outer part of the speculum far over to the side, at least forty-five degrees from the median line. This, too, should be done slowly and gently. Much more can be elicited from the tissues by gentle and persistent handling than by a sudden force that is apt to surprise them into resistance.

When there is a tendency for the vagina to distend and encroach upon the space needed for the bladder, as is often the case where a lacerated or dilated perineum exists, the patient should gently strain and expel the air from the vagina, after the speculum has entered the bladder and before the obturator is removed, then, by pressing the perineum against the anterior vaginal wall and removing the obturator, air enters the bladder, and its distension is accomplished. If the expansion is not satisfactory, the bladder being held in contact with the end of the speculum, it may be due to holding the breath, straining, an oblique position of the thighs, or a rigidity of the dorsal or abdominal muscles. See that the thighs are perpendicular and the back well curved toward the table; then, instructing the patient to breathe gently and to avoid straining, the wall will generally fall away from the speculum and permit a full examination to be made.

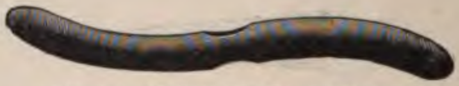


Fig. 94.—Kelly's Urethral Dilator.

During the examination the accumulating drip from the ureters becomes annoying, surging up to and filling the inner end of the speculum with each expiration. This may be removed by Kelly's appliance, consisting of a rubber tube 50 centimeters in length, with a rubber ball at one extremity, and a hollow, perforated, metallic sphere 6 millimeters in diameter at the other, for introduction into the bladder. If the metal ball is replaced by the long nozzle of a hard-rubber uterine syringe, this little contrivance will be found to answer the purpose perfectly, being more easily and quickly introduced and removed.

Dr. George E. Shoemaker devised and reported an apparatus for keeping the bladder dry. He used a quart bottle the cork of which was fitted with two rubber tubes. Through one of these the bottle is exhausted of air, and to the other is attached a ureteral catheter, which is inserted along the wall of the speculum, is too small to interfere with the field, and readily removes the urine. He has also had a small tube soldered in the lumen of the speculum, to the outer end of which the exhaust tube is attached.

If these appliances are not at hand and the urine accumulates rapidly, a quick and ready method of emptying the bladder is to withdraw the speculum until the inner end just reaches the neck of the bladder (shown by the appearance of a narrow ring of mucous membrane at the end of the instrument), and request the patient to rise from the knee-chest position to kneeling. This brings the inner end of the speculum to a plane below the rest of the bladder and empties it at once. A short explanation to the patient satisfies her and gives her a moment's respite by changing her position. Another method —the simplest of all—is to partly withdraw the tube and ask the patient to strain gently. This brings the acting floor of the bladder up to the opening, when by gently depressing the mouth of the instrument the desired object is accomplished.

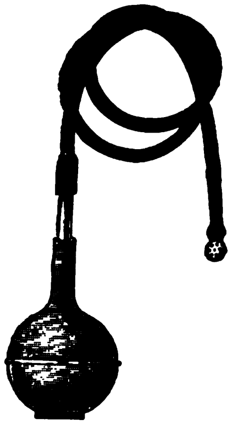


Fig. 95.—Cystoscopic Syringe.

To lessen the amount of urine excreted, see that the patient drinks no fluid for an hour before the examination is made.

It is essential that the bladder should be thoroughly distended, not only to open up all hiding places for erosions, ulcers, or other lesions, but that the mucous membrane may be presented in its true colorings. A partially contracted bladder is a shade darker or redder than when fully distended and might easily mislead in estimating the degree of inflammation. Several healthy bladders (with all possible aseptic precautions) should be previously examined, to learn the appearance of the normal organ.

It is not desirable to have the inner end of the speculum too near the wall. Withdraw from one-half to two inches, according to the degree of illumination. More of the field is seen at one glance and a better idea of relations secured.

The choice of light depends upon circumstances. In the office the electric headlight, with a reliable Edison-Lalande or other battery is satisfactory, providing one is fortunate in the selection of a lamp. These may last six months or a year, or they may be destroyed in a few minutes without redress from the dealers. When connection with the battery is made the highest resistance should be interposed at first, to prevent a possible destruction of the carbon filament. Without care, one may burn out a lamp in an instant.

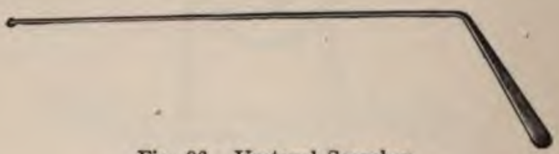


Fig. 96.—Ureteral Searcher.

If, for any reason, the electric headlight and battery are not to be obtained, the light from a good lamp or gas-jet reflected from a head-mirror will give satisfactory results, and, finally, in the absence of these, similarly reflected daylight gives all the illumination necessary, and has the advantage of presenting the parts in their true and easily recognized colors. In office work, therefore, the only essential instruments are a head-mirror, one six-millimeter speculum, and an aluminium applicator. A clear recollection of the nervous and vascular supply to the various organs of this region will go far toward a correct interpretation of symptoms, and the intelligent application of the proper treatment. One will lose no time in becoming thoroughly acquainted with the essential and relative anatomy of the parts.

Applications through the cystoscope are best made with a slender aluminium applicator, carrying a thin layer of cotton on the end. Care should be taken not to wrap too thickly, to avoid pinching a fold of mucous membrane against the sharp edge of the tube when withdrawing the applicator. The latter may be so thinly, yet serviceably, wrapped with cotton that the eye may follow it down the No. 9 tube to the spot to be touched, thus confining the medicine to the area needing it.

An important feature in connection with cystoscopy is the examination of the ureters. These pass diagonally through the wall of the bladder and enter it about one inch in front of the uterine neck, and from one-half to three-quarters of an inch from the median line. In order to bring them into view, the speculum should be turned about thirty degrees from the median axis, and, with the patient in the genu-pectoral position, the handle is depressed until the mouth of the ureter is brought into view. The appearance of this opening is not always the same, and is, at first, rather difficult to find. It may appear as a small dimple with pouting edges, a small slit, or an area of deeper color than its surroundings. A fairly accurate guide is found in the jet of urine issuing from it. If the kidney and ureter of the side under observation are intact, a small, shining line of urine may be traced upward to its emergence.

In rare conditions, probably of unusual stimulation of the ureteral muscular fibers, the mouth of the ureter is unexpectedly indicated by the appearance of a tiny stream of urine, such as would be projected from an hypodermic syringe, forcibly ejected across the inner opening of the speculum, sometimes striking its lower wall with a faintly audible tinkle.

Further discussion of the examination of the ureters will not be entered upon here, but attention is called to the fact that inflammation of the lower end of these tubes may, at times, be the cause of hitherto obscure and persistent backache, evidenced by the testimony of the patient, when the sound enters the canal, that there is where the trouble lies, and, afterward, by the disappearance of the symptom after proper treatment.

The color of the mucous membrane lining the bladder varies very much in different people, and at different times in the same subject. It is several shades darker for a week before the menstrual period, increasing as that time approaches, rendering it desirable not to examine at that time, except when the lesion is a very light one. It is then better to select that period, as an area of hyperemia that was not visible before becomes plainly so during the period of pelvic turgescence. It would be well, in such a case, to make two examinations: one a week after the menses have ceased and one the day before it is again expected. The contrast would indicate the relative integrity of the different capillary areas.

The average color of the healthy bladder is pale-flesh color, with occasional reddish or bluish streaks, very fine, generally short—not over half an inch, and sometimes dichotomous. These are the small veins, and are rarely altogether absent. The shade deepens as the neck of the bladder is approached, and at the sphincter is apt to be a deep red, which continues with gradual paling along the urethra to within a quarter or half an inch of the ostium, when it reaches the shade as seen without the speculum's aid.

Let each case be carefully and gently handled, both to avoid injuring the tissues and to reassure the patient's mind. Frequently the first attempt to examine an extremely nervous patient induces marked mental distress, and requires judgment as to whether to continue the efforts or wait until another time.

The air contained in the bladder is variously disposed of. If the treatment does not extend to the urethra, use the same procedure mentioned when speaking of the disposal of the accumulating urine: withdraw the speculum to the inner extremity of the urethra, place a small receptacle under the mouth of the instrument, and request the patient to rise to the kneeling posture. Urine and air escape, the bladder collapses, and the speculum is entirely removed.

If, as is often the case, the urethra likewise needs to be treated, the application is made during the slow withdrawal of the speculum, leaving the bladder distended with air. A soft-rubber catheter may easily be inserted and the viscus will be emptied when the patient either stands up or lies down.

Occasionally, when making applications at the patient's house, the rubber catheter is permitted to remain *in situ* for a variable length of time: from half an hour to four hours. This prevents a diluting of the medicament, and allows a longer period for its action upon the mucous membrane, but must be done tentatively, to avoid irritating it.

While it is not desirable to have a patient leave the office with air in the bladder, yet, should this occur, it rarely need cause anxiety. It is usually voided upon reaching home, with the first attempt to pass the urine, and is seldom followed by untoward results.

DISEASES OF THE RECTUM AND SIGMOID FLEXURE.

The frequency with which the physician in the practice of gynecology encounters diseases of the rectum makes it wise to add a few paragraphs on these conditions in which electricity is of signal service. This is an electro-therapeutic field that has been much neglected in spite of good work that has been recorded.

Anal Fissure.—In cocaine cataphoresis we have an excellent and almost painless method of healing these troublous conditions of the anal outlet, which will frequently make divulsion of the sphincter unnecessary. The patient is placed in position for examination, preferably leaning forward, face downward, over the head-end of a couch, and the anus carefully examined in the light of a head-mirror or electric headlight. When the painful erosion or fissure has been found the small pad is slipped under the abdomen and made negative, while the positive electrode, of platinum or carbon covered with absorbent cotton dipped in a 10-per-cent. solution of cocaine hydrochlorate is applied to the erosion and from 1 to 5 milliampères turned on for some minutes. Usually one application is sufficient to promote healing; at any rate it should not be repeated until a sufficient time has elapsed to test the possibility of healing having occurred.

Hemorrhoids. — Both external and internal hemorrhoids are readily and radically cured by making use of the coagulative and styptic action of electricity within the pile by means of puncture. Thanks to the anesthetic value of cocaine cataphoresis this procedure may be made almost painless, and the subsequent discomfort during the healing process is less than by any other method. The electric method, while radical in results and free from danger, possesses, therefore, the advantage of being possible without general anesthesia.

The patient being in the position described in preceding paragraphs, or in the Sims position, the pile is exposed to a good light, those within the sphincter by means of a rectal speculum, and a carbon or platinum electrode with cocaine solution on cotton applied as already described. The cocaine electrode is made to cover the most prominent portion of the pile which is intended to be punctured and the material diffused by anodic cataphoresis for about seven minutes with a current of from 15 to 25 milliampères according to the discomfort produced. At the end of this time a small platinum needle on a staff some six inches long (Fig. 97), insulated to one-fourth of an inch from the point, is inserted with but little sensation, and a current of from 5 to 20 milliampères turned on for ten minutes; a blanching effect is soon seen to occur in the pile, and the instrument may be withdrawn without bleeding from the point of insertion if sufficient current has been used.

This puncture will probably be sufficient for the one hemorrhoid; at any rate, healing should occur before repetition in that tumor, but other tumors should be sought for and a similar cataphoric application and puncture made at the same sitting if the patient's endurance of the posture continues long enough. If the needle has been insulated in such a manner that one-eighth of an inch of the shellac insulation will follow the point into the pile, further insertion being guarded against by a shoulder or bulbous portion of the insulation at the proper spot, the after-treatment is very slight, consisting of cleansing injections of hamamelic extract or a weak solution of creolin after defecation, with occasional applications of an ointment of either of these agents by means of a rectal ointment applicator.

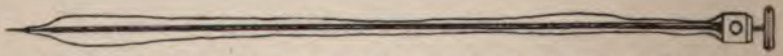


Fig. 97.—Author's Hemorrhoidal Needle Electrode (Sectional View, showing Appearance when Coated with Shellac).

The author has of late varied this application with advantage by employing zinc-mercury cataphoresis by puncture instead of simple positive puncture. Less current seems to be required, and the applications are themselves necessarily antiseptic.

The electrode may be made, a fresh one for each application, by cutting a narrow strip of zinc from a piece of No. 32 thickness, and insulating it with fused wax, in every way like the minor cancer electrode described at page 223, except that it is to be about six inches long. Connection with a No. 30 conducting wire is made as there described, and the insulation carried to less than one-fourth of an inch from the fine-pointed tip. A small opening is made in the hemorrhoid with a Hagedorn needle, after cocaine diffusion, the electrode is inserted, and the application made otherwise as described above.

Prolapse of the Rectum.—Moderate degrees of this mechanical displacement of redundant rectal walls may be successfully treated by a combination of two methods: labile intrarectal applications of the positive pole of a combined constant current of 20 milliampères and the primary induced (the author's rectal electrode [Fig. 73] being used) and submucous puncture.

The purpose of the labile rectal application of both currents is the stimulation of the muscular walls of the rectum and the various muscular structures adjacent, in order that the normal tone may be restored. This is usually followed by an immediate retraction of the protrusion, which frequently remains in proper position for increasing periods of time after this simple application. If made daily it may cure moderate conditions of prolapse without further elaboration of method. In the absence of the amalgamated-zinc electrode, with which it is proper to employ the positive pole (the mercury preventing cauterization under the moderate current and constant movement advised), the negative pole may be used with a rectal olive of any metal. The Sims position is usually the most convenient for this maneuver.

The purpose of the submucous puncture is the production of a cicatricial adhesion between the redundant walls and the underlying areolar tissue. Either pole may be used, the position of patient and anesthetic cataphoresis being the same as described in the puncture of hemorrhoids. The needle is inserted at but a slight angle with the longitudinal axis of the rectum, and about 20 milliampères used for ten minutes. But little can be accomplished by puncture, however, as the adhesions produced in such a manner are evanescent.

Stricture of the Rectum.—The unsurpassed value of electricity in strictures of the rectum is well shown in Newman's article in the "International System of Electro-Therapeutics." Its special action here, as in other strictures, is the dilating and softening effect of the negative pole and the possibility of causing absorption of the cicatricial fibrous structure causing the stricture. The size of the bulbs required makes it possible, as well as necessary, to use much more current than in the urethra, with added boldness of technique.

The instrumental equipment, in addition to the usual abdominal pad for a dispersing pole, consists of a rectal electrode with shank about nine inches long to which three or four sizes of bulbs may be screwed, varying in diameter from one-third to one inch. Semi-elastic shanks have been advised by some writers and repeatedly used by the author, but are rarely satisfactory in the firmer or narrower strictures, owing to one's inability to direct the bulb properly. An important improvement applied to these electrodes by the author is shown in Fig. 73, which is tunneled for attachment to a syringe in order that a cushion of water or oil may be made to precede the instrument, dilating the natural channel up to the point of the stricture.[1]

Essential elements of success in this work are a knowledge of the anatomy of the rectum and of its several valves, and extreme gentleness in passing the electrode to the contracted spot, where but slight pressure is demanded, the dilating effect of the current of 20 milliampères or more being relied upon.

Should the stricture bear evidence of being due to a malignant growth, the fact that the author's electrode bulbs are of zinc comes in play, since when well amalgamated the polarity of the instrument may be changed to positive after the diseased spot has been reached and a stronger application of mercuric cataphoresis made before it is withdrawn, as in the ulcerative condition described below.

Ulcerations and Adenoids of the Rectum.—For these conditions the mild zinc-mercuric cataphoresis is indicated, with current-strengths of 30 to 50 milliampères applied from olive-shaped zinc instruments. The results are most excellent, and could probably be attained in no other way.

---

[1] The author does not claim the tunneled rectal electrode as a novelty, except as applied to a dilating instrument for the upper rectum, hollow rectal electrodes having been devised by Boudet, King, Cleaves, and others.

CHAPTER XXIII.

THE COSMETIC APPLICATIONS OF ELECTRICITY.

THE chief cosmetic uses of electricity, in addition to the restoration of a normal clearness of complexion by electric stimulation of the liver and other abdominal organs, is the destruction of superfluous hairs on the face or elsewhere, the removal of small surface-tumors of the skin, moles, and warts; of nevi, or port-wine marks, and of pigmented nevi. Electricity, or, more particularly, the solvent action of the negative pole of the constant current, is, in every way, the best method of removing these blemishes, which, when situated on the face or other conspicuous portion of the skin, not only mar the appearance of the person, but are often responsible for an unhappy disposition in the persons thus afflicted. The skillful application of the proper remedy for these deformities is not the highest work of the educated physician, it is true, yet it is by no means beneath him, and, when it is remembered that the proper performance of the work demands a considerable knowledge of the anatomy and pathology of the skin, it is his duty to rescue it from the hands of ignorant charlatans.

Superfluous Hair.—The destruction of superfluous hair is accomplished by the electrolytic destruction of the germinal papilla at the bottom of the hair-follicle, and it may be said that there is no other known way in which this may be done without destruction of the adjacent skin. The world is indebted to Dr. W. A. Hardaway, of St. Louis, Mo., for the discovery of this fact, which has been further elaborated by Dr. George H. Fox, of New York, and the late Dr. Plym. S. Hayes, of Chicago. The pole employed is invariably negative and a current-strength of from $^1/_2$ to 2 $^1/_2$ milliampères is sufficient, according to the size of the hair and the duration of the application, when it is concentrated at the point of a fine needle inserted into the follicle. This amount of current may be obtained from a variable number of cells when a controller is used, though it is thought to be more painful if the voltage is greater than that obtained from about twenty cells. As the physician will be most apt to use the same apparatus for this work as that employed in ordinary therapeutic applications, it is only necessary to cut out some cells by a switch-selector or otherwise attach that number of cells to his switchboard. If the current source be the 110-volt Edison circuit the use of the author's new universal controller (Fig. 111) will permit a perfect adaptation of this circuit to this purpose.

The special instruments required are a needle, a pair of epilating forceps, the latter to be broad-pointed, nonserrated, and with a weak spring, and a hand magnifying glass.

A proper needle is a matter of extreme importance, since it is necessarily very fine to traverse the smaller hair-follicles which are already nearly filled with the hair themselves, yet the point should be so blunt as not to pierce the sheath of the follicle, but merely follow the hair to its base. Specially ground jewelers' broaches have been generally recommended, of steel, since the negative pole is invariably used, but I have preferred one less easily broken, which was originally made of 14-karat gold spectacle-frame material.

Since the last edition of this work the author has, however, made an important improvement in the method of epilation which requires frequent reheating of the needle in the flame of a Bunsen burner or alcohol lamp, and nothing will stand this procedure as well as irido-platinum. The essential point of the improvement is the insulation of the needle, except the action tip, with so fine a coat of fused hard rubber that the insulated needle will slip readily into the sheath and confine the pain and electrolytic destruction to the papilla itself. The importance of this modification of the older technique is evident; it greatly lessens the pain of the procedure because less current will be required and the current used will not affect the sensory nerve bulbs of the surface, but the most important advantage is the possibility of destroying hairs with a minimum of temporary disfigurement and absolutely no permanent scarring.

These improved needles are easily made by the physician himself. Procure twelve inches of No. 26 irido-platinum wire from a dental supply establishment and three pieces of hard-rubber tubing of about three-sixteenths or one-fourth of an inch gauge, each piece two and one-half inches long. This will be enough material for three needles complete, this number being required for proper work, since the coating, which is applied freshly for each sitting, will often not last during the half-hour of the average *séance*.

The irido-platinum wire is cut into three and one-half or four-inch lengths and each piece passed through a tubular handle and sealed in place with hard-rubber or black sealing wax, one end being turned over to make an eyelet for attachment of the conducting wire and the other filed down to a fine, blunt point for the active end. This form of handle is the best possible, being light, short and without any machinery for interrupting the current by hand—a mistaken method in the older needle-holders. The conducting cord is simply a piece of No. 32 covered copper wire of suitable length, threaded securely through the eyelet.

To apply the coating, heat the end of the needle and at the same time set on fire the end of a piece of half-inch hard rubber; while the rubber is burning and fused, bring the fused portion in contact with the hot needle, and observe the result through a magnifying glass in a good light. A tiny portion of the needle should show at the tip, above which the insulation should present a smooth, thin coating to the required height to insulate the needle from the skin when inserted. Several attempts, followed by re-fusing the coating over the burner, will often be necessary for each needle. All three needles should be attached to the negative pole ready for interchangeable use, as required.

The patient is placed in a large chair by many, but the writer prefers in this and all other face applications that she lie on a couch in a good light with her head well up on the head-piece, the operator sitting behind and leaning over with his elbows resting on the side of the pillow. The poles of the battery are thoroughly identified and the positive binding-post connected with a moist pad laid on a waterproof in her lap, on which the patient presses her hand to close the circuit and raises it therefrom to break it at command, the pad becoming thus a delicate controller to make and break the circuit without suddenness.

Everything being in readiness, the needle, connected with the negative pole with a very fine insulated wire, is inserted into the follicle without piercing its walls, the patient is directed to press the pad, the proper amount of current is turned on through the Massey controller, which is not thereafter disturbed, and the action of the current noted. When the hair is loosened, as it will be in a few seconds, if the needle has been properly placed, it is removed by the forceps in the other hand of operator; the patient is directed to raise the hand, when the needle is removed, reinserted into another follicle, and the process repeated. The patient's hand is always up, therefore, when the needle is either inserted or removed, greatly lessening the pain, which is often considerable. After the skin has been broken by an application a strong solution of cocaine should be spread over the surface, and though the polarity of the electrode will not carry the cocaine in by cataphoresis, the action being, instead, anaphoric, a distinct dulling of sensation will be soon manifest from it, doubtless by absorption through the little punctures made. If four hairs are removed at the angles of a surface a little over a half-inch in area the inclosed space quickly becomes anesthetized, permitting the hairs within it to be removed at this sitting without sensation. But it is not wise to remove hairs closely contiguous, unless using the insulated needle described above, owing to the tendency of the little cauterizations to coalesce, producing too noticeable a scar. The *séance* should not be prolonged beyond a half-hour at a time, in the interest of both patient and operator.

A few hair-papillas will escape destruction at the hands of even skilled operators; but they are readily removed when they reappear. To guard against an undue number of these, care should be observed not to remove the hair until it is thoroughly loosened.

Moles and Warts.—The special advantage of negative electrolysis in the removal of both moles and warts is that it enables us, by a nice adjustment of the destructive action to the actual tissue to be destroyed, to devitalize the little tumor at one sitting without the destruction of the underlying skin, as with acids or the knife, the slight scar left for a few weeks disappearing entirely after a time. The details are practically the same as for the removal of a hair, except that a sharp, curved needle is used, passed into the growth a little distance above its base, and that about 5 millimpères is usually required, turned on very gradually. The current should be continued until the growth is quite disintegrated in the case of moles, but warts often disappear after only a partial destruction of their bases, apparently by an influence on their nutrition. In either case the crusts should be left undisturbed until they fall off, to avoid scarring.

Nævus Vasculosus (Port-wine Mark).—This congenital dilatation of the capillaries of the skin is at times of large extent, constituting a serious disfigurement. Its treatment, which necessitates an occlusive inflammation of the capillaries, is both tedious and painful, yet the results obtainable are fully worth the effort. The active pole, negative, to avoid undue scarring, consists of a number of needle-points projecting from a disk, enabling as many punctures to be made simultaneously. The current is empirically regulated and maintained (at about 3 milliampères per needle) until a white wheal appears at each puncture, when it is turned off and the instrument reapplied at another place. The result of each healed puncture is a minute white scar at its site, and it is therefore necessary to repeat the application a number of times at intervals of a month in order that the whole surface may be turned into a slightly roughened cicatrix, which is far more sightly than the nevus.

The application is quite painful and for a thorough treatment it is wise to employ anesthesia, particularly since the applications are necessarily at long intervals. It is possible that if the needles were of irido-platinum and the positive pole used the greater scarring from short applications would be of advantage, but the author is not aware that this has been tried.

Nævus Pigmentosus.—This form of nævus, characterized by the deposit of pigment within the skin and frequently by the associated growth of superfluous hairs, is treated in the same way as the vascular nævus, the hairs being first removed in the usual way. The pigment is, at times, apparently decomposed by the electrolysis, the metallic constituents being deposited on the negative needle.

In the case of an infant of 11 months, with a large brown spot on the face, seen some years ago, the author employed a fine curved needle mounted in a needle-holder, and applied as much as 15 milliampères for prolonged periods, under chloroform. The needle was curved on the flat, enabling it to be slowly swept over the area while closely observed through a magnifying glass. This strength of current dissolved the delicate cuticle and apparently robbed the pigment cells of their pigment, which was washed off with a pledget of cotton, discoloring four ounces of water. The action of electrolysis apparently caused the pigment to pass from the body to the needle—an outflowing cataphoresis. After several applications the results were permanent, and there was but little scarring.

CHAPTER XXIV.

INSTITUTIONAL TREATMENT.

THE importance of electricity as the chief therapeutic agent in the management of the neuroses and of many chronic disorders of an organic nature; its close association with massage, seclusion from accustomed environment, and other features of the rest-cure method; together with the necessity for costly equipment and special facilities for the application of strong currents in certain physical diseases, render some mention of institutional treatment specially appropriate to these pages.

The practice of medicine is on the eve of evolutionary changes of vast magnitude. Closely associated with witchcraft, divination, and the black art in past ages, it has not been wholly emancipated from superstition even in the present century, in spite of a progress greater than the combined achievements of all preceding ages, for this progress has been largely confined to investigations as to the causation and accurate recognition of disease, and its cure by surgical methods, leaving the extension of knowledge relating to the cure of disease by medical methods in a less advanced condition. The reason for this can only be the vast difference in the facilities offered for good work in these several departments, in both Europe and this country. In the leading European countries the governments directly foster and support investigations relating specially to diagnosis, and in both Europe and America, particularly in the latter, numerous hospital establishments favor the development of surgical art.

The absolute necessity of hospitals for good surgery, and the ease with which charitable institutions may be made available for this work, has resulted in a one-sided development of these establishments, which has rendered them, at times, of but little service to purely medical art.

And there are many reasons why this should be so. A well-ordered charity hospital may do ideal work in surgery, for the master-hand itself may do the brief work that makes for success or failure, leaving unessential details to less skilled hands; but the medical treatment of a charity case, in its best and most complete form, can rarely be administered by the chief physician without a far greater sacrifice of time than he is able to make. This results in the whole machinery of the hospital being developed in a surgical direction, leaving it but imperfectly adapted for the treatment of any medical cases other than those acutely ill, or in whose cases the mere administration of drugs is sufficient.

The charity hospitals have, therefore, been of but small value in the development of remedial arts as applied to the cure of nonsurgical chronic ailments, for, in spite of a full appreciation of the value of drugs in this class of affections, it is not overstating the bare truth to say that they are of but little use. It is to natural forces and other physical agencies, carefully selected and applied by skilled specialists, that we must look for therapeutic advances that shall be commensurate with similar advances in allied fields, and that this may be done it is absolutely necessary that special institutions be created for this particular purpose. It is but a remnant of superstition to rely upon advice and prescriptions when the whole environment of the patient needs remedial adaptation; and this remedial adaptation can only be employed with adequate means and adequate appliances.

Special institutions, thoroughly adapted to particular lines of work, are, therefore, a most necessary adjunct to modern medical progress, and the author looks forward to the time when their value will be as well appreciated by the profession in all chronic affections as the modern hospital is appreciated as a means for good surgery. That the people for whose benefit they will be created already understand the value of institutional treatment is shown by the success of institutions now well patronized by them, some of which were established by uneducated persons.

When this desirable improvement in the care of the nonsurgical sick has been fully established, we will no longer be so inconsistent and untrue to our work as to present the spectacle daily witnessed of a physician prescribing mere drugs for well-to-do patients in a back parlor in the morning, which is bare of remedial appliances for the proper treatment of the persons who pay him for the highest expression of his art, and in the afternoon catering to paupers in the splendors of a perfectly appointed hospital. If the hospital facilities add to the welfare of the charity patient, surely institutional facilities are equally useful to the more deserving citizen. In reality there is a greater necessity for well-equipped work in battling with the ailments of intellectual beings, aside from the moral obliquity of a civilization that reserves its best services for its defective classes.

The value of institutional facilities is particularly great in the practice of electro-therapeutics, owing to the magnitude of the instrumental equipment required and the necessity for certain classes of applications being performed under such circumstances that the patient may rest in bed immediately afterward. It also permits of a closer attention to details on the part of the chief physician, through an economy of his time, and makes it convenient to associate with the main element of treatment other remedial agencies of great service in this class of cases, such as scientific massage, radiant heat-baths, good nursing; regulation of dietary, rest, and exercise; and the mental medicines of discipline, expectancy, and environment.

PART II.

RUDIMENTS OF MEDICAL ELECTRICITY.

CHAPTER XXV.

PHYSICS OF THE CONSTANT, OR DIRECT, CURRENT.

WHILE our knowledge of the true nature of electricity itself is yet indefinite, it is fortunate that its manifestations in motion—the only condition in which it is of service to the physician—are as real, comprehensible, and measurable as a simple current of water. If there is mystery attending its use in medicine it is the mystery of all remedies applied to yet imperfectly understood physiologic and pathologic processes.

Certain facts relating to their noncompressibility have led recent investigators to regard electric currents as currents of a real fluid. Be this as it may, the fact that their laws in motion are exactly analogous to those of hydraulic currents has enabled us to frame a definite mental picture of them, and assists us greatly in a comprehension of their qualities.

If we examine a stream of water issuing from a reservoir (Fig. 98) we will find two qualities which will not be difficult to separate in the mind: pressure and volume. The former is the force by which water transports itself, due to gravity, and depends on the height of the water in the reservoir. It is the same in all pipes issuing from it, whether large or small. The volume of water carried by a pipe, on the other hand, depends on the size and length as well as on the pressure.

Electromotive Force (Pressure).—In electric currents the force governing the transportation of the energy is called electromotive force, due to a kind of electric gravity, or heaping up of energy at the positive pole. This force is likewise independent of the size of the conductors attached to its reservoir, but the bulk, or volume, of the current will depend on the size and length of the conductor as well as on the electromotive pressure.

Just why a contrivance such as a voltaic cell should give rise to the pressure leading to current-flow is not so clear as is the analogous pressure origin in water-currents. It is easy to conceive that a water-current will flow downward through pipes by virtue of the actual weight of the water, the available weight being proportional to the vertical height of the water-column. All that we know of the cell-origin of electric pressure is that it is an inherent quality of any two metals that one is positive to another when both are plunged into an acid or saline bath, and that a current starts from the submerged surface of the positive element toward the submerged portion of the negative element and emerges at the unsubmerged portion of the negative element. The *upper portion* of the negative element (Fig. 100) is, therefore, the *positive pole*, as it is at this point that an accumulation of electric energy occurs in a cell, while a corre-

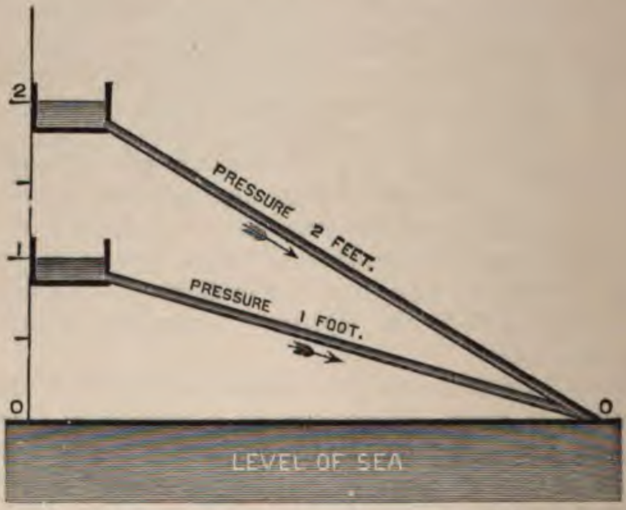


Fig. 98.—Diagrammatic Representation of the Cause of Flow in Hydraulic Currents. The pressure, measured by a vertical scale of feet, is due to the elevation of the source, or reservoir. The amount of water delivered will depend on the caliber of the pipe as well as on the height of this pressure.

sponding deficiency is found at the *upper portion* of the positive element, constituting the *negative pole*. When the two poles are united by a conductor, such as a wire, the body, etc., a current flows from the positive pole to the negative pole in response to Nature's effort to re-establish an equilibrium. It is, however, the peculiar virtue of a good cell that the difference of level is maintained by chemic action between the liquid and the elements, resulting in a constant maintenance of the pressure at the positive pole and a continuous current-effort at equilibrium until either the chemic activity of the liquid is exhausted or the positive element is consumed. We can ascertain the direction of the current always by knowing that it is invariably the positive element that is consumed, on the surface of which the current begins. By knowing this, we know that the outer portion of the opposite plate is always the positive pole of the cell. It so happens that zinc is almost invariably used as the perishable element in a cell, and usually carbon the unattacked element; hence the positive pole of such a cell is the outer portion of the carbon, or a wire attached to it.

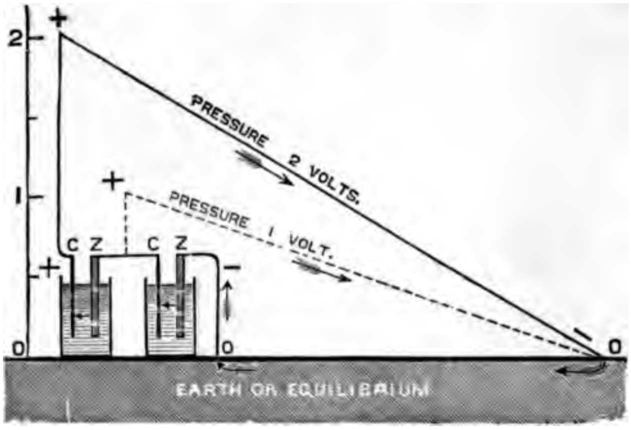


Fig. 99.—Diagrammatic Representation of the Cause of Flow in Electric Currents. The pressure (or electromotive force), measured by a scale of volts, is due to the elevation of the electric level of the positive end of the conductor by the particular generator in use. The amount of current delivered will depend on the size and conductivity of the wire as well as on the height of this pressure.

A voltaic cell with its circuit "open"—*i.e.*, without conducting material connecting its poles—may be said to resemble a small reservoir full of water with the outlet closed and ready to supply a current to a pipe. When the poles of the cells are connected and a current flows it is like the same reservoir with valves open, supplying a current of water to its pipes, the water-level in the reservoir being maintained by pumps that are analogous to the chemic action within the cell.

But the voltaic cell is by no means the only method by which electromotive force may be created. Fig. 101 indicates how a dynamo, electric machine, or induction apparatus may cause a pressure by heaping up energy at the positive pole, showing its analogy to a pump.

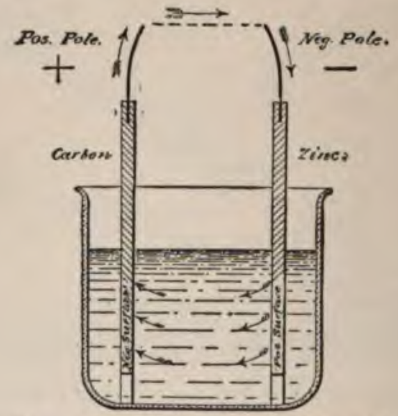


Fig. 100.—Diagram of Direction of Current within a Cell.

The Volt.—The unit of electromotive force, or pressure, is the volt; so named after Volta. It has been derived from mathematic calculation, based on fundamental units of length, mass, and time,—the centimeter, gramme, and second, or C. G. S., system of units. The physician, however, needs but to remember that the practical volt is almost exactly the amount of electromotive force produced by a good zinc and copper cell, known as the Daniell cell. Two such cells, arranged in "series" as in Fig. 99,—that is, with the zinc of the first connected with the copper of the second,—will raise the potential in the circuit to two volts. Five such cells will give five volts and ten cells ten volts, the unconnected copper of the first cell being the positive pole of such a battery and the unconnected zinc of the last cell the negative pole. Of the cells in medical batteries it may be said that all zinc and copper cells possess an electromotive force of about one volt, zinc and silver cells about the same, and zinc and carbon cells with sal ammoniac solution about 1.4 volts. The best commercial carbon-zinc dry cells have a pressure of 1.5 volts. When the zinc and carbon elements are used in an acid bichromate solution, as in the portable batteries of this type, each cell has an electromotive force of about 2 volts. A thirty-cell acid battery yields, therefore, a current with a pressure of 60 volts when freshly charged. Each cell of a storage battery has an electromotive force of 2 volts also, when fully charged.

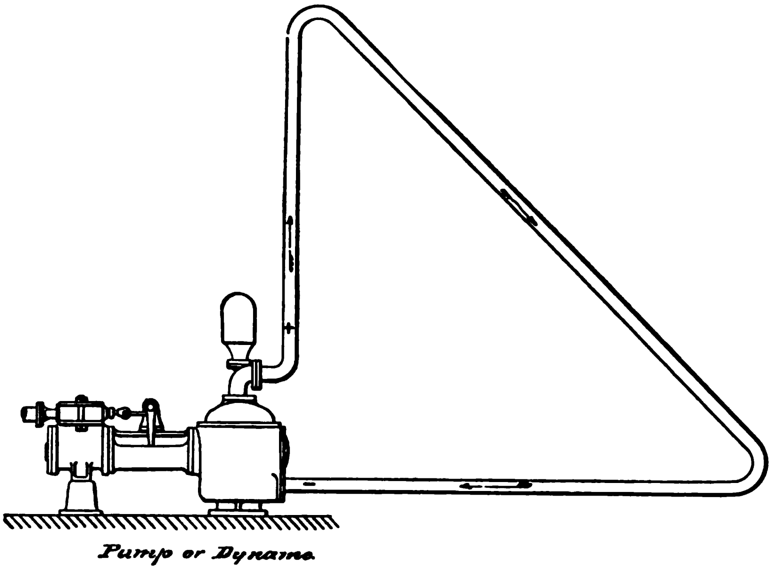


Fig. 101.—Diagram Showing Analogy of Laws Governing Pressure in Pump and Dynamo Circuits.

Resistance.—It was said above that the pressure of an hydraulic current from a reservoir of a certain height was independent of the size of the pipes through which it issued, being the same whether the pipe was large or small. The amount of water passing through the pipes will, however, depend on their caliber, and the frictional resistance of the water against the sides of the pipe. The caliber of an electric conductor is equally important in regulating the volume of the current that will pass through it from a given pressure, while a certain frictional resistance to electric conduction exists in the metallic conductor itself not unlike the internal friction of the pipe.

The Ohm.—The adopted unit of resistance is the ohm, named for Professor Ohm, of Germany, and is equal to the amount of resistance presented by a column of mercury one meter high and one millimeter thick. A more convenient idea of this amount of resistance is conveyed by the statement that it is equal to that presented by one hundred feet of No. 20 copper wire. This wire is the size usually employed in installing annunciators and electric bells. Two hundred feet of this wire will give a resistance of 2 ohms, four hundred feet, 4 ohms, and so on. If the wire be double the area in cross-section, however, the resistance will be but half for the same length. The resistance of a conductor is therefore directly as to its length and inversely as to its cross-section.

An excellent illustration of these facts is the immense difference shown in the length of the following commonly used sizes of copper wire required to give one ohm resistance, the difference depending entirely on their caliber:—

Lengths of Copper Wire in Common Use Required to Give One Ohm Resistance.

No. 40 (an entremely fine wire, rarely used)	1 foot
No. 36 (the wire with which the fine-wire secondary is wound)	2.3 feet
No. 32 (a fine wire employed as conductor with author's tuberculosis electrodes)	6 "
No. 28 (employed as conductor with minor zinc-mercury cancer electrodes)	15 "
No. 26 (employed with major zinc-mercury cancer electrodes)	23 "
No. 20 (employed in annunciator and bell wiring)	100 "
No. 0 (smallest trolley wire)	2 miles
No. 0000 (trunk-line trolley wire)	4 "

Specific Resistance.—Homogeneous conductors, such as metals or solutions of definite proportions, present differing resistances, however, even in conductors of the same size and length. A No. 20 iron wire, one hundred feet long, for instance, will present a resistance of 5.36 ohms, because an iron wire of the same size and length has a resistance 5.36 times greater than copper. This differing facility of conduction is an inherent quality of different substances, and is called their specific resistance. It is probably due to a frictional resistance to flow presented by the constituent molecules of the conductor. The resistance of copper is taken as the unit of comparison, or 1.

TABLE OF SPECIFIC RESISTANCES.

METAL.	SPECIFIC RESISTANCE.
Silver	0.77
Gold	1.38
Aluminum	2.29
Zinc	2.82
Iron	5.36
Tin	6.76
Platinum	7.35
Lead	9.96
German silver	10.09
Antimony	18.07
Mercury	47.48
Bismuth	64.52
Graphite	1106.00
Gas-carbon	2037.00

The Law of Ohm.—In hydraulic currents it has been said that the volume of the water circulating in a pipe will depend on the pressure, on the one hand, and the caliber and length of the pipe on the other. The corresponding relation of pressure and resistance to current in electricity is known as Ohm's law, having been formulated by Professor Ohm in 1827. It is mathematically expressed by the formula

$$\text{C (current)} = \frac{\text{E (electromotive force)}}{\text{R (resistance)}}$$

or that the current is equal to the electromotive force divided by the resistance.

Units of Current.—*The Ampère.*—The bulk, or volume, of a current circulating in a conductor is measured in ampères. This unit of current-volume is fixed as the amount circulating through a resistance of 1 ohm from a pressure of 1 volt. A Daniell cell would, therefore, maintain an ampère through one hundred feet of No. 20 copper wire if its own internal resistance could be excluded. About $^{1}/_{2}$ an ampère circulates through an ordinary sixteen-candle power incandescent light bulb.

The Milliampère.—For medical purposes the ampère is too large a unit; hence the milliampère, or $^{1}/_{1000}$ ampère, is used for this purpose.

The Coulomb.—The current delivered every second by a circuit having a pressure of 1 volt and a volume of 1 ampère is equal to a coulomb, the unit of measure for current-quantity. This unit, or its corresponding diminutive, the millicoulomb, is rarely used in medicine, unless electrolysis alone, and not the additional effects of more or less suddenly applied volume, are required. A record of the milliampères used and the duration of the application conveys more information than a mere record of the millicoulombs would.

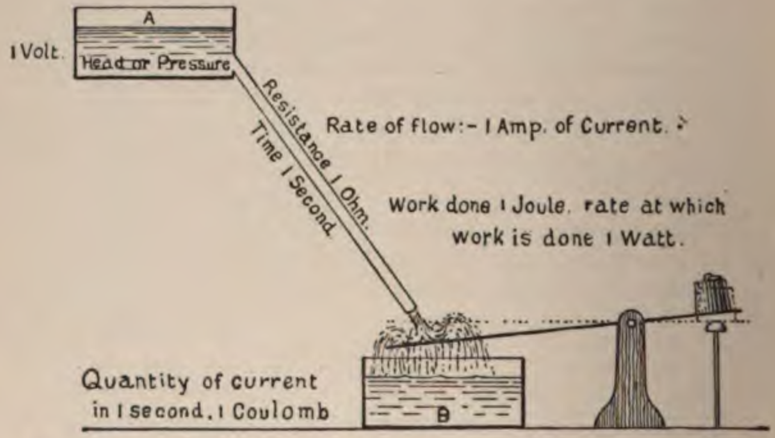

A
1 Volt.
Head or Pressure
Resistance 1 Ohm.
Time 1 Second
Rate of flow:- 1 Amp. of Current.
Work done 1 Joule, rate at which work is done 1 Watt.
Quantity of current in 1 second, 1 Coulomb
B

Fig. 102.—Diagram Illustrating Electric Units by the Water Analogy. (From *Hedley*.)

Internal Resistance of Cells and Batteries.—In a circuit made up of a battery and external conductors there are two kinds of resistance to be reckoned with in estimating the whole amount to be encountered,—viz., the internal resistance, or that given by the solutions and elements within the cells, and the external resistance, or that given by the wires, cords, electrodes, and body. Incandescent currents may be said to have external resistance only, as the internal resistance of the vast reservoir made up of street mains, dynamos, etc., is too small to require the physician's attention from this point of view.

Application of Ohm's Law to the Arrangement of Cells.—The various needs of electricity in medicine require that currents of varied pressure and volume be used, the pressure being employed, as a rule, merely for the purpose of carrying sufficient volume through the tissues. If but a milliampère or so is required the pressure need not be great, but if a large volume is desired to be passed through the poorly conducting skin the pressure must be from 50 to 100 volts. A single Leclanche cell gives a pressure of about 1 $^{1}/_{2}$ volts. To get a current of 75 volts from a battery of such cells we must arrange fifty of them "in series," as in Fig. 103,—that is, with the zinc of the first attached to the carbon of the second, and so on. Such a current will have sufficient pressure to carry the usual amounts of milliampères required in medical applications, but it will not heat a cautery-knife, because it will be impossible to get more current-volume from

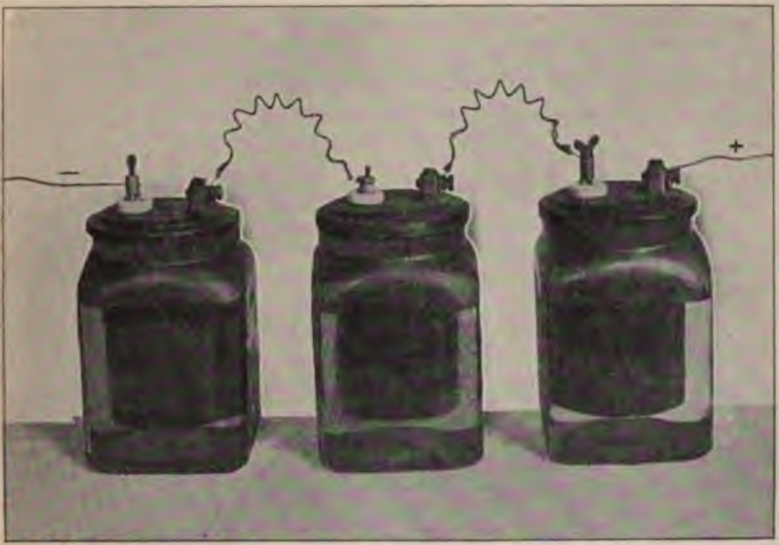


Fig. 103.—Three Cells Connected "in Series."

the whole battery thus arranged than can be obtained from a single cell on short circuit (or working with its poles connected directly without appreciable external resistance), because its output will be limited by its own internal resistance. To increase the output in the latter case we must decrease the internal resistance, which is done by either increasing the size rather than the number of the cells, or by arranging the cells "for surface" or in multiple arc,—that is, with all the carbons connected together as the one positive pole and all the zinc connected together as the negative pole, thus making them one cell many times larger than the original one (Fig. 104). The internal resistance in this latter arrangement is decreased by broadening the path of the current through the battery itself. By a computation of the internal resistance of cells and a calculation of the pressure required to overcome the external resistance we can easily tell whether we need a few large cells or many small ones.

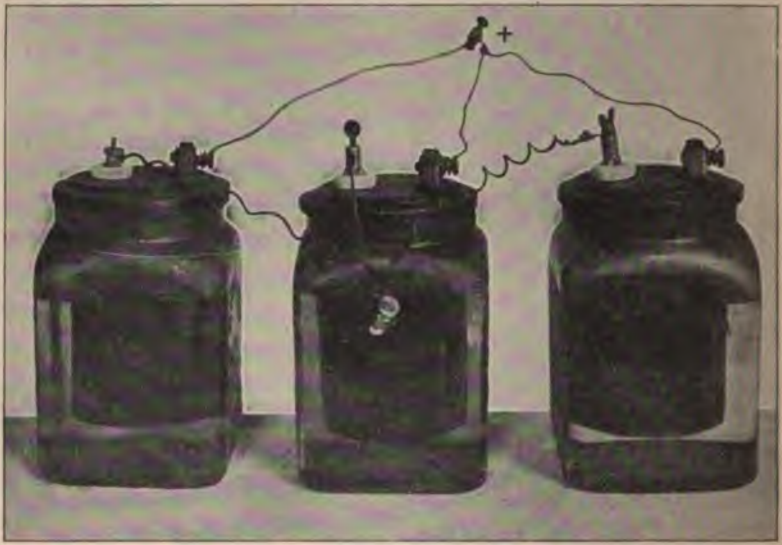


Fig. 104.—Three Cells Connected "for Surface," or in Parallel Arc.

To the mathematic mind but little effort is required to comprehend such facts. To those rusty in figures I commend the following graphic delineation of the law of Ohm as applied to currents from cell-batteries, an ideal cell with an electromotive pressure of one volt and an internal resistance of one ohm being depicted for convenience of illustration:—

Fig. 105 shows to the eye the effect made on the current-volume from a single cell by inserting various amounts of resistance into the external circuit. The cell has a typical pressure of 1 volt and a typical internal resistance of 1 ohm. When its terminals are joined by a short band of copper, so thick as to present no appreciable resistance, the current-volume produced is 1 ampère. If, now, the short band of copper be replaced by a coil presenting a resistance of $^1/_{10}$ ohm, making, together with the internal resistance of the cell, a total of 1 $^1/_{10}$ ohms, the resultant volume will be diminished to $^9/_{10}$ ampère.

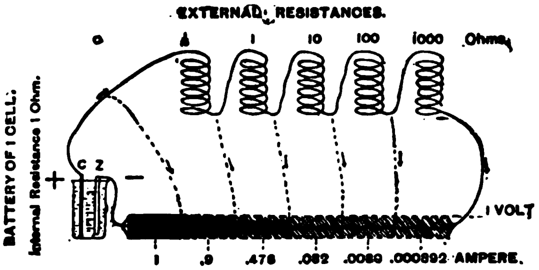


Fig. 105.—Graphic Delineation of the Pressure and Volumes of Currents from a Single Voltaic Cell when Various Resistances are Inserted into the External Circuit. The cell shown at the left of the cut has an electromotive pressure of 1 volt and an internal resistance of 1 ohm. The divisions of the drawing to the right of the cell represent imaginary longitudinal sections of the currents obtained on short-circuiting the cell and after successively inserting into the circuit the several resistance coils indicated in the upper portion of the figure. The heavy shading in the first three divisions shows the exact proportions of volume to the eye as compared with a full ampère, indicated by the broken lines. The light shading shows the proportion of pressure, which is uniformly maintained throughout. The volume in the last three spaces is indicated by the figures beneath, but is much too small to be shown to the eye on the scale adopted.

When another coil, giving a resistance of a full ohm, is added, the total now being 2 $^1/_{10}$ ohms, the volume maintained is less than $^1/_2$ ampère. A corresponding reduction of the volume occurs, with the inclusion of each additional amount of resistance in the external circuit; and when the whole series of coils is placed in circuit, aggregating, together with the internal resistance, a total of 1112 $^1/_{10}$ ohms, the current-volume is brought down to less than $^9/_{10}$ milliampère.

The resistance of the body with approved electrodes may be said to be represented by the last two coils of the figure (from 100 to 1000 ohms), while that of the platinum loop of the galvanocautery knife is nearest that of the first coil. The effect of increasing the cell to twenty times its size (or coupling twenty similar cells for surface—*i.e.*, all the zinc to one pole and all the carbons to the other) —is shown for both uses in Fig. 106, demonstrating the value of the method with the slight external resistance and its inefficacy for the greater. The effect of an increase in the voltage in passing more cur-

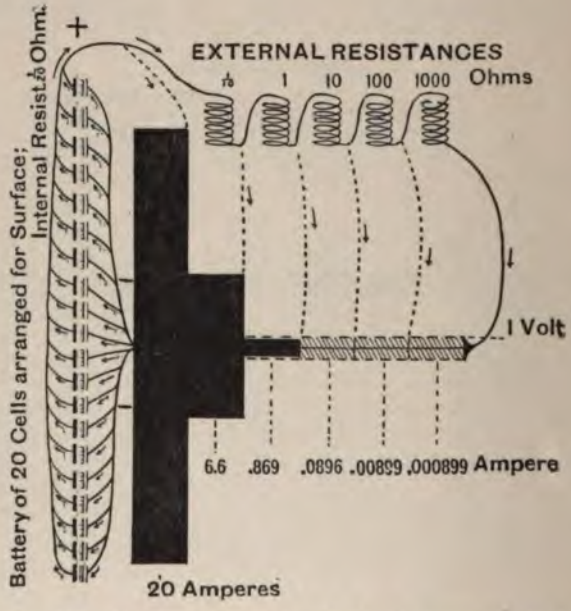


Fig. 106.—Graphic Delineation of the Pressure and Volumes of Currents from a Battery of 20 Cells Arranged "for Surface." The battery, acting as an enlarged cell, has an electromotive pressure of one volt and an internal resistanc of $^1/_{20}$ ohm. Th first three imaginary current-sections show the proportions of volume to the eye.

rent through the higher resistances is shown in Fig. 107, which also displays the disadvantage of this method in the low resistances, as the additional cells bring with them additional internal resistance.

The great amount of internal resistance given for each cell in these diagrams is a legacy from days now largely passed, as the much used carbon-zinc dry cell of the present time has so small an internal resistance as to be capable of giving as much as 20 ampères or more on short circuit.

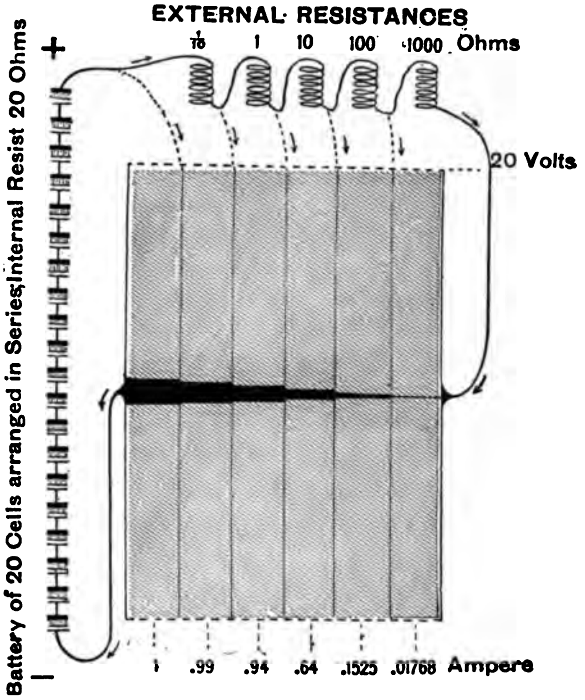


Fig. 107.—Graphic Delineation of the Pressure and Volumes of Currents from a Battery of Twenty Cells Arranged "in Series." The battery has an electromotive pressure of 20 volts and an internal resistance of 20 ohms. The heavy shading in the first five imaginary current-sections shows the exact proportion of volume on the scale of the preceding cuts. The space allotted to represent pressure is reduced, for convenience, to one-half the scale adopted in Figs. 105 and 106.

CHAPTER XXVI.

THE PRODUCTION AND CONTROL OF CONSTANT CURRENTS.

THE constant currents used in medicine are procured from batteries of cells arranged to give sufficient voltage (from 10 to 150 volts, according to the nature of the medical work) or from reliable direct-current incandescent light mains, the latter usually having a pressure of 110 volts. In either case the currents are modified by an applying apparatus consisting essentially of a controller and meter, with the necessary switches and binding-posts. Where reliable Edison incandescent circuits are available that are either under the absolute control of the operator or placed underground and kept free from danger of contact with arc-light and trolley-car wires and kept constantly supplied with current, there is no reason for the physician to use a battery as a source of current. All batteries require intelligent care and are likely to give more or less trouble in replenishing and repairs, all of which is relegated to the dynamo-house in the case of incandescent circuits. Yet no one should begin the use of an incandescent circuit until he has assured himself by investigation that his circuit is free from the defects and dangers referred to.

SOURCES OF CURRENT.

The 110-Volt Direct-Current Street Mains.—Being assured that there will be no possible interruption of the current to be delivered from the 110-volt Edison direct-current mains,[1] its use in medical applications is very simple, the two supply wires being attached to an apparatus possessing a proper controller, whether it be a cabinet or table switchboard, just as the wires leading from the carbon and zinc elements of the battery are attached. The polarity of each wire should first be tested as follows: Having attached a double conducting cord to a plug, unwind a few inches of the other end of the cord and bare a half inch of each conductor. Do this before the plug is placed in the receptacle. Having bared the ends, separate them two inches, insert the plug in the receptacle and turn on the current at the key, if there is a key. Keeping the ends from touching (lest the fuse blow out), insert the two ends in a glass of water in which a teaspoonful of table salt has been dissolved, and it will be noted immediately that one wire gives off twice as much gas as the other. This wire is the negative pole. It should be attached to the *N.* binding post of the apparatus at once and the other wire to the *P.* binding post.

---

[1] The Westinghouse system of incandescent house-lighting, so largely used in smaller towns, employs an alternating current totally unlike those considered here, and, of course, lacking in the properties of a direct current. Its employment in medicine is referred to elsewhere.

It should be remembered that this test applies to the plug in this receptacle alone. Whenever the plug is changed to another receptacle it should be tested again.

Much was said a few years ago about the danger of using street currents for medical purposes. In the author's opinion, this is confined to overhead wires alone, where a broken telephone or telegraph wire might fall and connect an arc-light circuit with the incandescent circuit. The only precaution required in underground circuit mains refer to the protection of the instruments from burning out, which is done by placing a 2-ampère fuse in circuit and seeing that no switch will short-circuit the current. This latter precaution is specially necessary when using a switchboard devised for cells, since all of the old-time apparatus possesses switches that short-circuit the cells each time they are moved.

Fig. 108 shows the proper plan for wiring a switchboard for the constant current derived from the direct-current mains of 110 volts. It is arranged with the protecting fuse wire in the plug attached to the cord, where it may be readily replaced if accidentally blown out. As will be seen in the diagram, the full 110-volt current may be supplied to the controller (where the current should always be conveyed first) by closing the right-hand switch. Should the work in hand require a very small current it may be cut down somewhat by using the left-hand switch, when it traverses the resistance of the lamp (which may be either a 50-candle, 32-candle, or 16-candle lamp, as we wish a lesser or greater resistance). But one switch should be closed at a time. When the right-hand switch is closed the circuit to the controller is shown by the unbroken lines; when the left-hand switch is used, by the broken lines.

It is important always to place the meter beyond the controller, in the patient's circuit from the latter, for the reason that the waste current passing through the controller and directly back to the mains will not then pass through the meter, destroying the accuracy of the latter's readings. When the meter is thus in the patient's circuit alone its readings will show only the actual current passing through the patient.

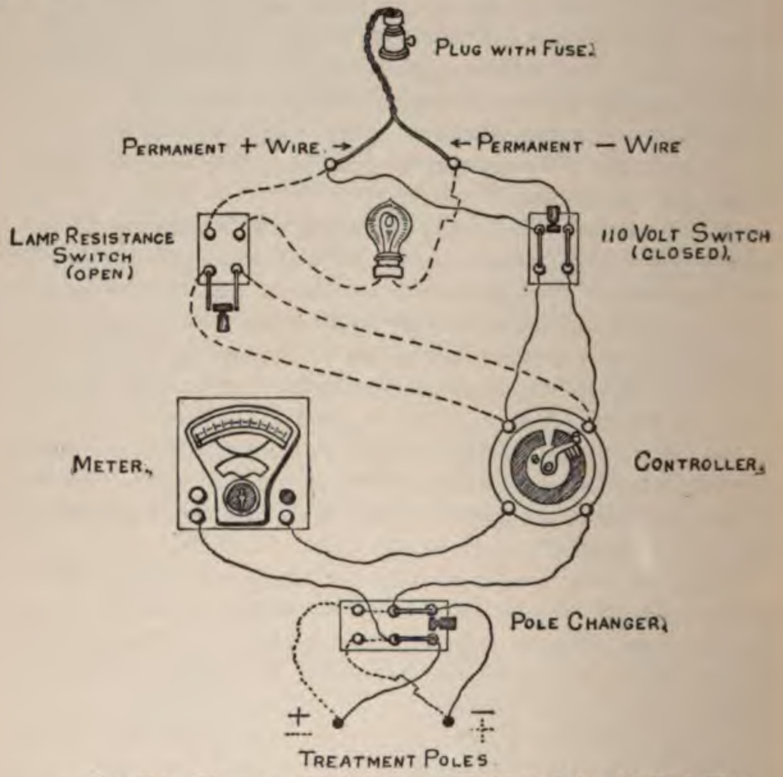


Fig. 108.—Diagram of Wiring of Switchboard for Medical Use of 110-Volt Direct Current from Street Mains. The shunt lamp of the author's new universal controller is not shown.

By placing the pole-changer below the meter we may use a one-direction meter like the Weston, as the direction of the current is then changed or reversed at the pole-changer only after it has passed through the meter.

In handling the electrodes and cords of an incandescent circuit thus arranged one must be careful not to bring the metallic parts of opposite poles together unless the controller is turned off, or nearly off. This precaution is merely to preserve the fuse or instruments from being burned. There is absolutely no other danger from the use of a proper circuit of the Edison current, as the full strength of this circuit can force no more current through the body than can the full strength of any good battery of seventy or eighty cells. To avoid such accidents to the apparatus the controller should always be kept with the crank at the starting-point when not in actual use, and the metallic parts of the electrodes and cords should never otherwise be brought together. Both switches are left open when not in use.

The Vetter current tap (Fig. 109) may be used as a plug without losing the use of the lamps previously occupying the receptacle from which it is desired to take the current. These taps are made with the lamp "in parallel," when the full voltage is obtained for therapeutic use, or with the lamp "in series" with the therapeutic supply, the lamp in the latter case doing the service indicated by the one shown in Fig. 108.

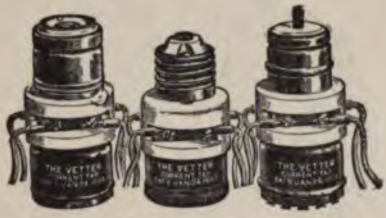


Fig. 109.—Vetter Current Tap, with Connection for Westinghouse, Edison, or Thompson-Houston Receptacle.

The Current Controller.—This instrument, which, when properly constructed, enables the 110-volt direct current from the mains to be modified, without shock, to any strength desired, is also equally valuable in the control of the current from a stationary battery of cells, permitting the cells to be evenly used, without the short-circuiting that results when the old-fashioned cell collector is employed.

The author's graphite controller shown in previous editions of this work was first designed and termed a "current controller" in 1887, since which time the aptness of the designation has caused the name to be applied to the governors of trolley cars and other industrial users of current of various kinds. The original Massey graphite controller was simply a graphite resistance placed in series with the patient and the mains. This reduced the current somewhat unevenly, merely "choking" it, without adequate reduction of the voltage.

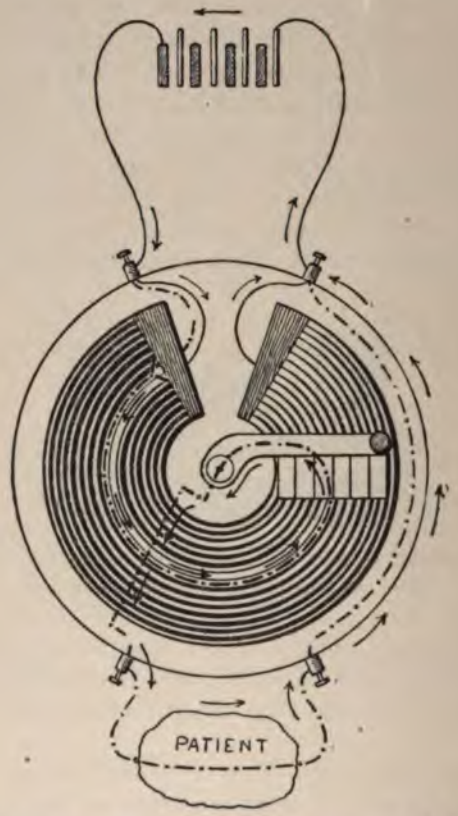


Fig. 110.—Route of Current in Patient's Circuit in Jewell Graphite Controller. The broken line indicates the patient's circuit. The graphite area itself offers a parallel route for direct return of a portion of the current.

W. S. Hedley[1] has shown that a better plan for the construction of a controller is to place the patient in shunt, or parallel, with a body having a less resistance, the current dividing the voltage between the two as the controller arm is turned on. Unfortunately Hedley employed wire resistances, which are impracticable as a means of readily and smoothly controlling the voltage. As for the button wire "rheostats" or controllers largely employed in this country, their use is always attended with a jump of a volt or so at each button, causing the increase of the current to be far more unpleasant than desirable.

---

[1] "Current from the Main," Lewis & Co., London; and "Therapeutic Electricity," P. Blakiston's Son & Co., Philadelphia.

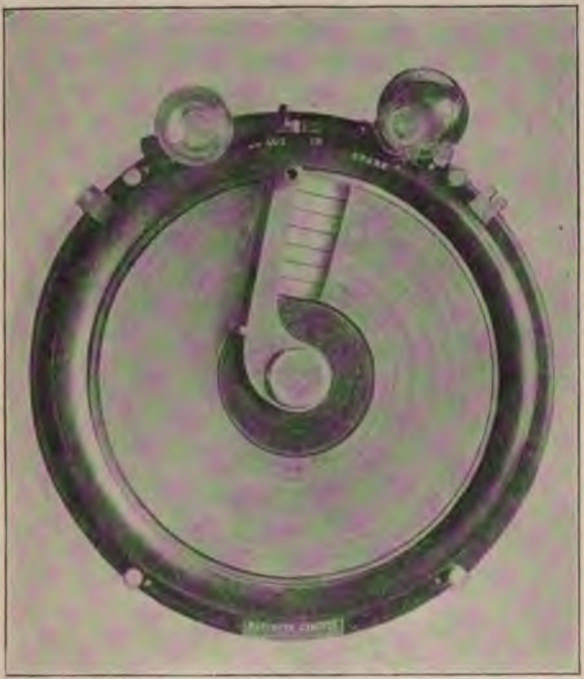


Fig. 111.—The Massey Universal Therapeutic Controller. The lamp to the left is the series lamp; that to the right the shunt lamp. When the series lamp is cut out by the switch and the shunt lamp turned off at its key the instrument is merely an enlarged Jewell controller, the added size permitting the range of current strengths to be increased to as much as 2000 milliampères. When the switch (seen between the two lamps) is turned to put the series lamp in circuit and the shunt lamp is turned on at its key, the instrument becomes a volt controller, permitting currents of as little as $^1/_{10}$ milliampère to be employed with a low voltage.

The Jewell controller, made of graphite, was an advance in the construction of graphite controllers because it retained the smoothly increasing qualities inherent in the use of graphite, and added a partial observance of the shunt principle by allowing a small portion of the current to go directly through the graphite area back to the mains without traversing the patient. The route of the current traversing

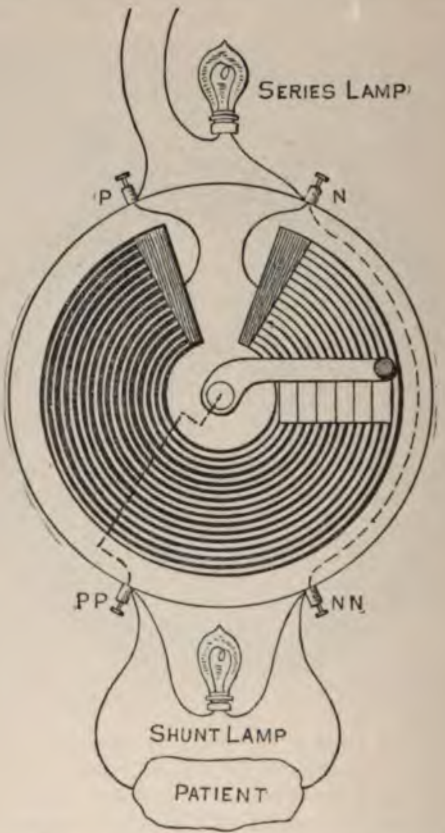


Fig. 111*a*.—Plan of Wiring of Universal Therapeutic Controller. The series lamp may, of course, be put in either the right or left leads from the mains. The path of the current through the controller proper is the same as shown in Fig. 110. One purpose of the series lamp is the preservation of the graphite from burning out with excessive current when the shunt lamp is in use.

the patient is shown by the broken line in Fig. 110, the lines indicating the graphite, showing the route of the direct return to the mains.

While the author cannot agree with Dr. Hedley that the "current of the mains" should never be used with a simple series' resistance, for he has so used it for years in his first type of controller and since with the partial shunt controller of Jewell, he recognizes the principle that 5 milliampères from a current with a voltage of 110 will be more painful than the same current from a voltage only sufficient to overcome the resistance. He has, therefore, recently modified the graphite controller by enlarging it and placing a 16-candle lamp *parallel and in shunt with the patient's circuit,* the lamp being capable of being thrown in or out of circuit by merely turning the key attached to its receptacle. This improved and enlarged controller is shown in Fig. 111, which illustrates an instrument of the greatest value in electrotherapeutics, since it enables us to select any voltage desired from the 110-volt mains, with currents from $^1/_{10}$ milliampère to 2000 milliam-

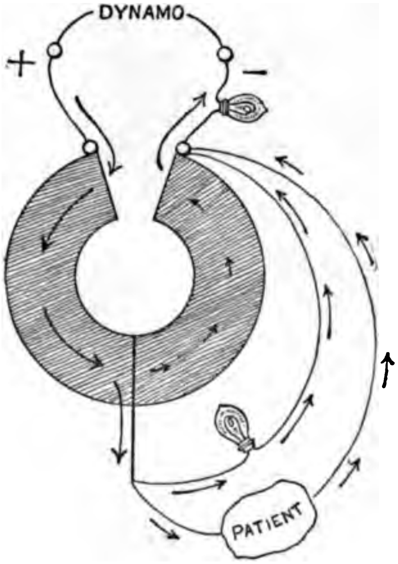


Fig. 112.—Diagram of the Several Paths, or "Shunts," of the Circuit of the Author's new Universal Controller. The size of the arrows shows approximately the relative proportions of the current in the several paths, though this varies with kind of application.

pères, increased and decreased with absolute smoothness and without complicated movement. A simple sweeping movement of the lever handle turns the current on or off as often and as rapidly or slowly as desired.

In using this instrument with the 110-volt current the following variations are possible, giving great range to its capabilities for fine or heavy work:—

1. *With both lamps turned off* (in the series lamp by cutting it "out" at the switch) it is adapted to control the full 110 volts by variation of resistance from 0 to 2000 milliampères. This adapts it to heavy current work, and also for the induction and sinusoidal currents.

2. *With the series resistance lamp* at the left *turned on* at its switch it is adapted to constant currents below 300 milliampères by simple variation of resistance, the current being turned on more slowly by the same movement of the handle. 3. *With both the resistance and shunt lamps turned on* it is adapted to control voltage as well as milliampèrage, giving a less painful current for the finer work, such as applications to the eye, epilation, etc., and in this position the controller will light 4- and 6- volt lamps perfectly.

Fig. 112 shows diagrammatically the several paths taken by the current in the new controller, the voltages automatically adjusting themselves to the varying relations of the three circuits as the handle is turned on or off. For clearness of illustration the moving contact is shown as if extending over the graphite from without the area instead of from within. The meter should be placed in the extreme right hand circuit only.

Any Jewell graphite controller may be turned into a full shunt controller by connecting a series and a shunt lamp as depicted above; but, as the shunt lamp absorbs most of the current, the range of strength then obtainable from a controller of this size is rather below 40 or 50 milliampères. It will be seen, nevertheless, that this addition to the instrument will render it useful to those employing small currents. By unscrewing the lamp, or turning it off with a key attached to the receptacle, the action of the controller is restored to its former range.

The question of the value of this volt control in administering labile constant currents is undoubted. When making minor electrochemic applications, such as prolonged minor zinc-mercury cataphoresis, its value is less certain, for the pain element of current variation is here absent, and the reduced voltage makes the current at times variable because more subject to the effect of tissue polarization. The ability to turn a full-shunt controller into an ordinary resistance controller by turning off the shunt lamp enables us to select any method desired in a given case.

The Meter.—This instrument is also indispensable to the physician, who has no more right to subject a patient to the influence of an unmeasured current of electricity than has a pharmacist to fill a prescription with unweighed or unmeasured drugs. The number of cells employed is incapable of giving definite knowledge, owing to the varied resistance of the skin in different individuals.

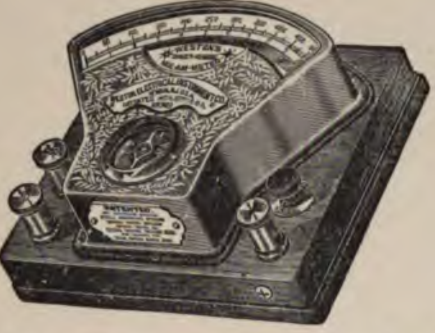


Fig. 113.—Weston Milliammeter, Arranged Specially for Medical Work. There are two scales, the upper measuring to 500 milliampères in divisions of 5 milliampères, for which the negative wire should be attached to the binding post marked 500; and the lower scale, measuring to 10 milliampères in divisions of $^1/_{10}$, for which the negative wire should be placed in binding post marked 10. The pointer at the right should always be turned up when using the upper scale and down when using the lower. The positive wire is always placed in post with plus mark.

Without entering into details as to the construction of these instruments, for which the reader is referred to rudimentary treatises, it is sufficient to say that until the construction of the Weston ammeter in 1889 the industrial users of electricity as well as physicians were dependent on meters constructed on the principle of the deflection of a compass needle by a current. These are all liable to alteration and deterioration, seriously affecting their value after various periods of use, and are, moreover, affected by neighboring masses of iron or steel. The Weston meter is constructed on a different principle, the mutual induction of coils, and is now accepted both at home and abroad as a standard of correct measurement. It has two scales, the upper reading from 0 to 500 milliampères and the lower from 0 to 10 in tenths, the scales being unusually large and readable. It is also so constructed that the lower, or red, scale may be used as a voltmeter for the measurement of an electromotive force below 100 volts when it is in circuit with the resistances contained in a small box accompanying it.[1]

The convenience of having an instrument capable of testing the voltage of cells and batteries that may be imperfect or needing repair, without extra cost, will be greatly appreciated by physicians.

All meters of this type have one binding screw marked for the positive pole and are, therefore, not adapted for a reversal of the current through their mechanism. The commutator, or pole-changer, of a switchboard should consequently be intercalated in the circuit between the meter and the patient, rendering reversal easy, without disturbing the course of the current through the meter.

Wall Plates and Cabinet Apparatus.—A number of manufacturers furnish excellent cabinet apparatus and wall plates with graphite controllers. Should the physician be tempted to buy any such not supplied with the graphite controller he would do well to specify that this essential feature of a proper applying mechanism be added to the instrument.

---

[1] To measure the voltage of a battery or cell below 10 volts the zero-marked binding post of the resistance box is connected with one binding screw on the instrument and another wire is carried from the cells to be measured to the resistance box post, marked 10; the reading of the lower scale will then indicate the volts and tenths of volts when the circuit has been properly closed from the opposite pole of the tested cells to the meter. To measure the voltage of a whole battery (of 100 volts or less) the same connections are made, except that the wire is changed to the binding screw of the resistance box marked 100, these readings being also on the lower, or red, scale and each division normally representing the tenth of a milliampère now reading a volt. The binding post on the meter marked with a + sign should be connected with the carbon wire of the tested battery as in the ordinary use of the instrument as a milliammeter.

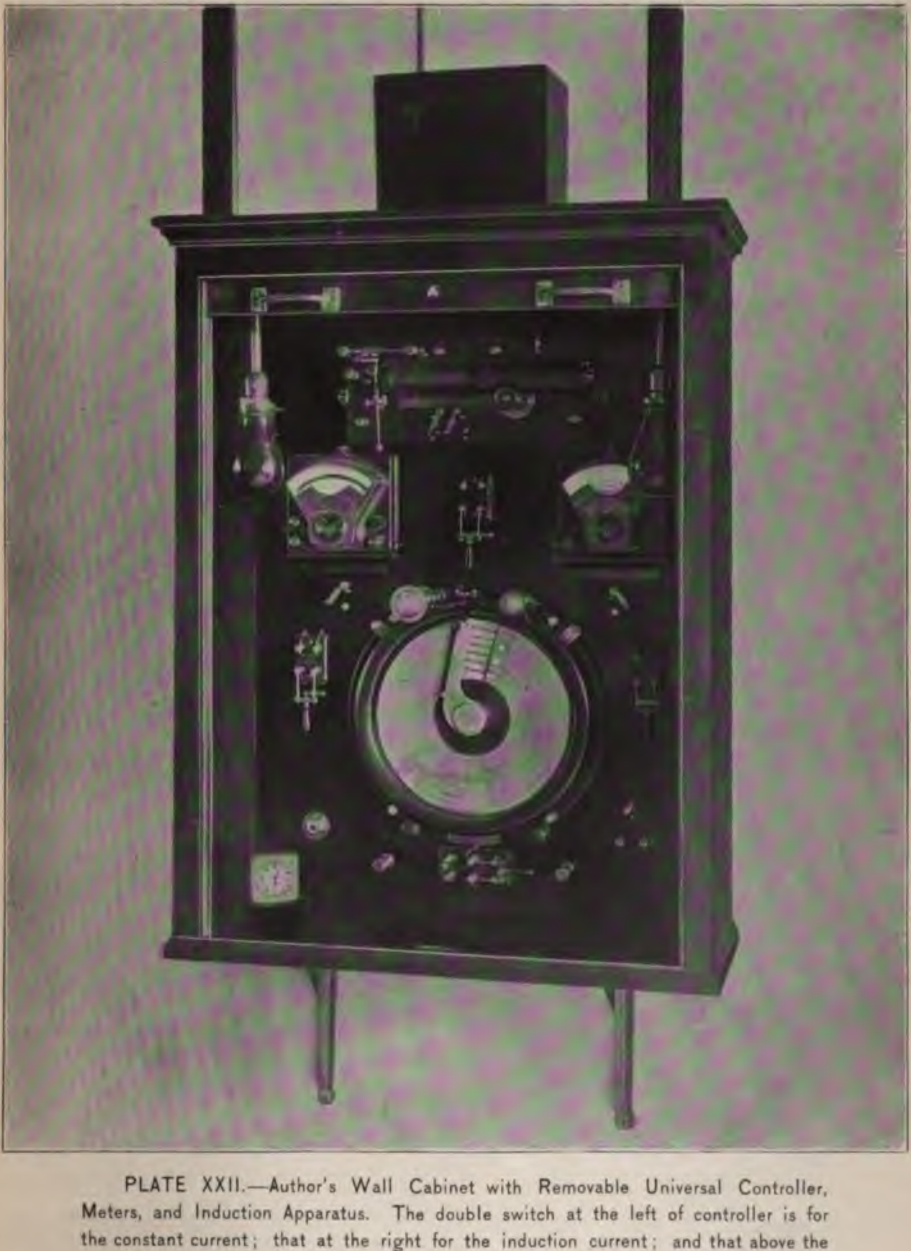


PLATE XXII.—Author's Wall Cabinet with Removable Universal Controller, Meters, and Induction Apparatus. The double switch at the left of controller is for the constant current; that at the right for the induction current; and that above the meter for both combined. No two of these switches should be left closed at the same time.

The author has recently devised the wall cabinet shown in Plate XXII in order that the large controller shown in Fig. 111 may be used in the office for both delicate as well as heavy work (the large area of graphite adapting it to very delicate volt and milliampère gradation),

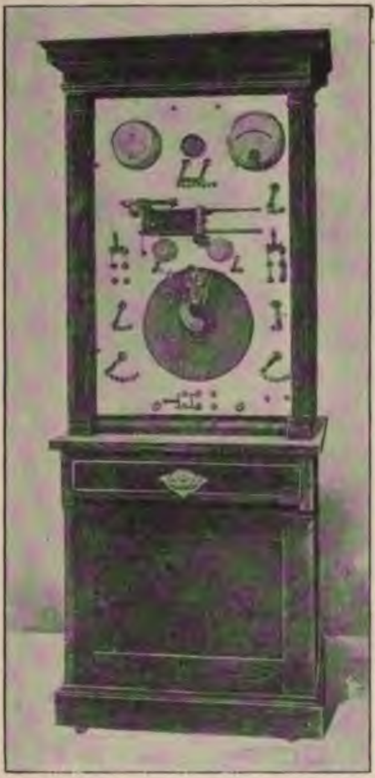


Fig. 114.—The Author's Arrangement of Wall Cabinet and Universal Controller, as Manufactured by Frank S. Betz Co., Chicago. This instrument may be used with either the 110-volt direct current or dry cells. Unless specially ordered the parts of this excellent apparatus are not removable.

the controller, meter, and even the induction apparatus being removable from the cabinet at will. One controller and meter may in this way be made to do duty as both a stationary and portable instrument, boxes for carrying each being supplied by the manufacturer, Otto Flemming, Philadelphia.

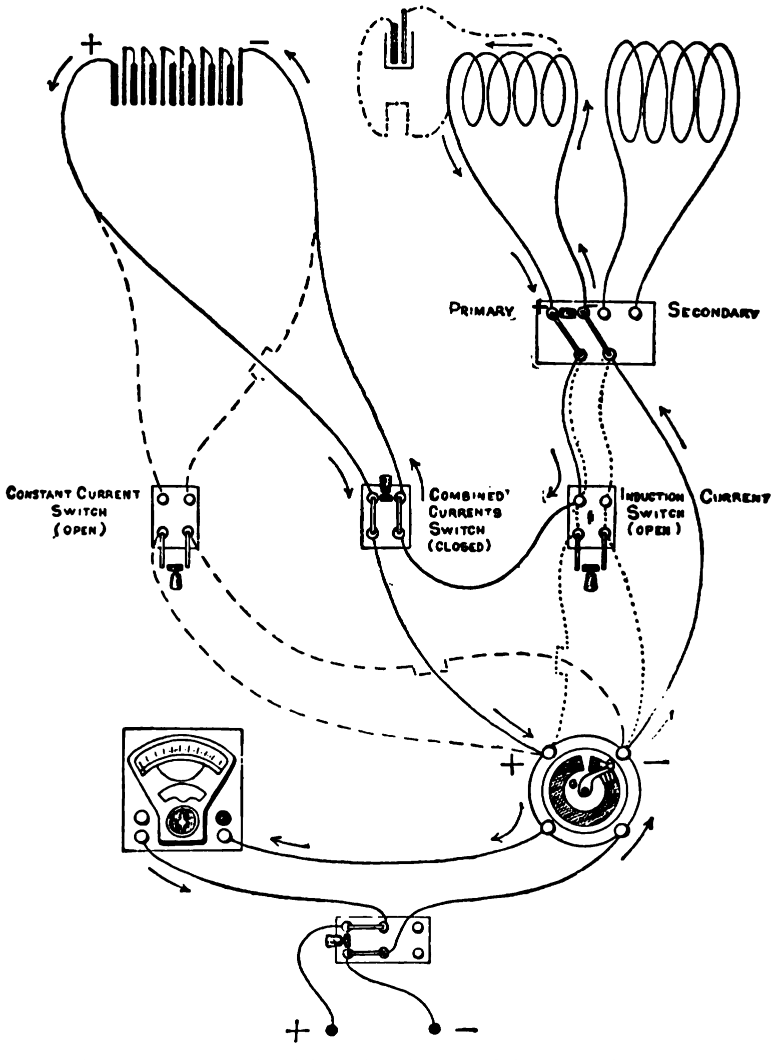

+
−
PRIMARY
SECONDARY
CONSTANT CURRENT SWITCH (OPEN)
COMBINED CURRENTS SWITCH (CLOSED)
INDUCTION SWITCH (OPEN)
CURRENT
+
−
+
−

Fig. 115.—Plan of Wiring of Switchboard for Both Constant and Induction Currents, with Switch for Combining Both Currents for Simultaneous Use. The 110-volt constant current or cells may be used. If the 110-volt circuit is employed for the constant current, dry cells should be used for the operation of the induction coil in order that both currents may be used combined. The shunt circuit of the controller and its shunt and series lamps are not shown.

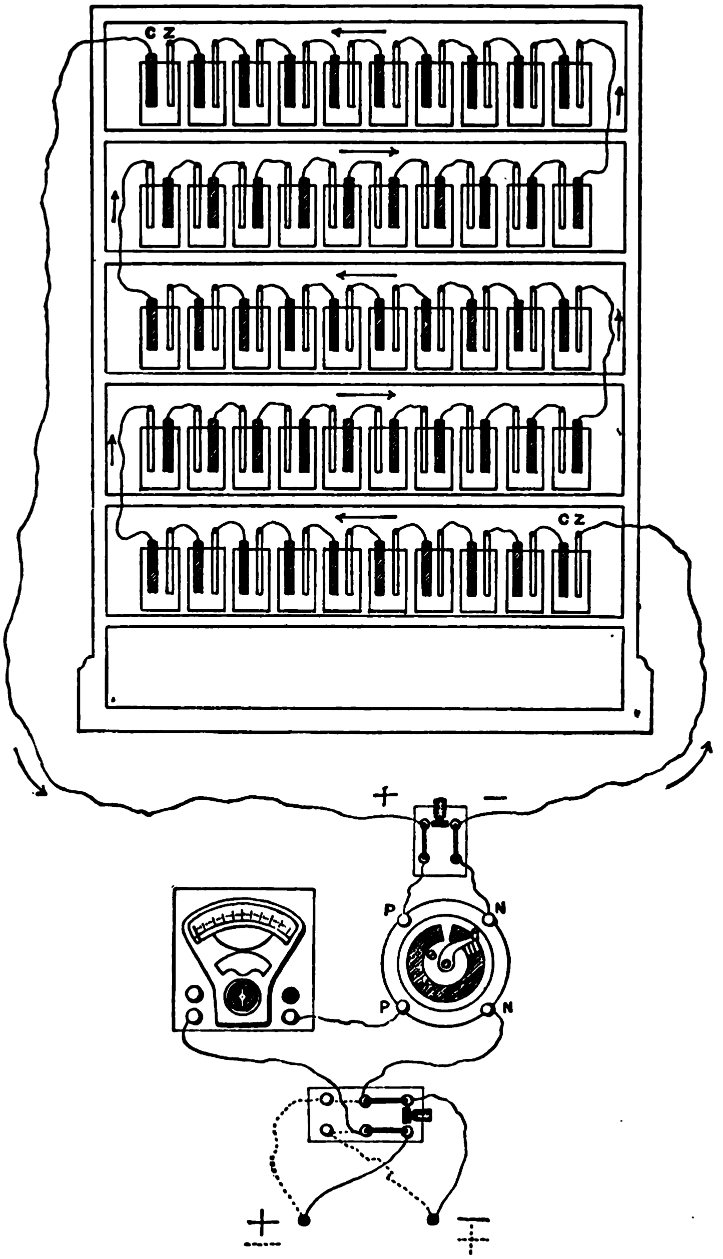


Fig. 116.—Arrangement and Proper Plan of Wiring of Stationary Battery of Cells, with Controller and Meter in Circuit. The switch should be left open when not in use.

Stationary Battery of Cells.—Where a battery of cells is required as a source of current, and it is to be used in the office or hospital building only, a stationary battery of permanent primary cells is essential. Such a battery consists of from 40 to 75 cells arranged in a series on shelves in a cabinet or convenient closet. By arrangement "in series" is meant that the zinc of the first cell should be connected by a wire or other connector with the carbon of the second cell, the zinc of the second with the carbon of the third, and so on. When all the cells are thus connected it will be found that the carbon of the first cell and the zinc of the last one are free. A wire attached to this carbon will be the positive pole of the battery and another attached to the zinc will be the negative pole. The current from such a battery must be used through a controller and meter placed permanently and directly in series, as shown in Fig. 116, the battery wires taking the exact position of the street mains in Fig. 108. These wires, or "mains," may be carried throughout an institution, terminating in a pair of binding posts on a wall-board, each binding post being permanently marked with the proper polar sign, after due ascertainment of the identity of the pole.

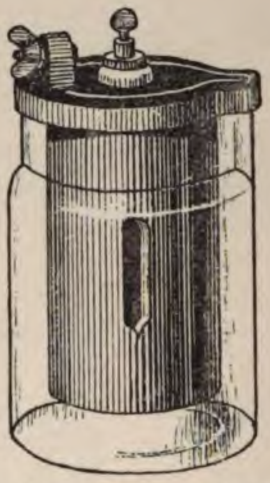


Fig. 117.—Carbon Cylinder Cell.

The only cells worth considering for this purpose are reliable carbon-zinc dry cells, or the open-circuit bell-ringing cells easily procured from first-class hardware stores in any part of the country, now that electric bells are so common. These are all one or another variety of the Leclanche cell, consisting of carbon and zinc elements in a saturated solution of chloride of ammonium. These cells are said to be of the "open circuit" variety because they remain in good condition for long periods while unused, or with the circuit open. If used on a circuit of low resistance for many minutes at a time they tend, however, to run down by polarization, but will recover if allowed to rest. The particular variety of the wet-cell type now universally used is a simple carbon cylinder cell, the cylinder made in one piece with the cap, the zinc passing through an insulated opening in the latter. In setting up these cells care should be observed not to permit the solution to wet the upper edge of the jars, as this would favor capillary "creeping" of the salts. The zincs should be cleaned at least once in six months, and if renewed at the end of a year or eighteen months will postpone a thorough overhauling for a much longer time when the battery receives but moderate use.

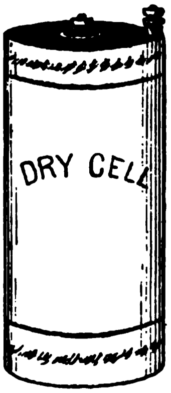


Fig. 118.—Carbon-Zinc Dry Cell. The central attachment is connected with the carbon element.

The author has been frequently asked his opinion as to the desirability of a physician's purchasing a standard size of the patented commercial dry cells now largely used in place of these "wet" varieties of the original Leclanche cell, and the reply was always until recently in favor of the wet cells. Of late, however, these dry cells have been greatly improved, and there is no reason why they should not supplant the wet sal ammonia cell in the office of a physician who does not care to spend much time upon his batteries himself or be troubled with the often unsatisfactory labor of others. The standard size of the Columbia cells are said to be the best. They should be connected up exactly as depicted for the wet cells in Fig. 116 and their use has this decided advantage: that sixty of them may be arranged in two boxes of thirty each, thus taking up less room than the wet cells, and permitting one box to be taken about at will as a thirty-cell portable battery, if the boxes are furnished with terminal binding posts similar to those employed for the large cells shown in Fig. 119, to which a portable meter and controller can be attached at will. When kept in the office as a permanent battery the + pole of one box is to be connected with the — pole of the other, the remaining terminals being attached to the main supply terminals of the applying apparatus. Such an arrangement permits the same cells to be used for both stationary and portable work.

The applying mechanism, whether table or wall-plate or cabinet, is wired in exactly the same way for a battery of cells as for the current from the mains (see Fig. 116 for diagram of the wiring of both the cells and the apparatus) the two special lamps being turned on in the latter case, and the same apparatus may therefore be used with either source of current. The switch between the cells and the controller is even more essential than with the street mains, as the slight current wastage of the controller would run the cells down, while in the case of the street mains only the bills for current used would be affected.

It is desirable at times to have both sources of supply on tap in the apparatus. This can be easily arranged by attaching the cell mains to the series lamp switch shown in Fig. 108, the lamp and street mains having been disconnected from this switch. The polarity is, of course, properly considered. When this switch is closed, the other two being open, the controller delivers the cell current instead of the street current.

Portable Batteries.—The practice of electro-therapeutics is at last definitely delivered from the incubus of the acid battery, that abominable contrivance that was so necessary if any but the slightest currents were used, yet so troublesome to keep in order. The chief drawback of these batteries was not the handling of acids, bad as that was, but that they were sure to get out of order if not constantly used; and there is no doubt but that their unreliability has been a most effective drawback to the extension of electrochemic therapeutics. The definite relief has come in the recently attained efficacy of the commercial dry cell. Many physicians have unfortunately invested in the chloride of silver dry cell batteries. It is not of this type that the author speaks, for these are mere medical toys, but of the zinc-carbon type so largely used in the arts and industries, of which the Columbia make is most reliable. The value of this make of dry cell can be attested by the author, whose attention was first attracted to it by the report of the Committee on Constant Current Generators and Controllers of the American Electro-Therapeutic Association for 1903. The chairman of this Committee, Prof. W. J. Herdman, of Ann Arbor, Mich., submitted this cell, with others, to a prolonged test in the Electro-Therapeutic Laboratory of the University of Michigan, and summarizes the results as follows:—

"A glance at the record sheets, copies of which I herein submit, will show how this form of dry cell, the Columbia, has stood this test. Constancy and durability it has shown to a remarkable degree, and a certain change, a corrosion of the inclosing zinc covering and a tumefaction or bulging of the sides of the cells at the point of corrosion, which has been observed in so many other forms of dry cell, I have never seen in the cells of this make. This corrosive action of dry cells, which I have noticed in many other types, takes place whether the cell is in action or not, and always to its detriment. It seems to be due either to an excess of acid, as a primary condition in the semi-fluid electrolyte, or such instability in that electrolyte that local action takes place when the circuit is open. This defect seems to have been overcome in the construction of the electrolyte used in the Columbia cell and seems to fit it, in this as in other particulars, for electro-therapeutic service to the exclusion of many, if not all, other forms of dry cell now on the market."[1]

The best portable battery is made of thirty or forty of the best type of zinc-carbon dry cells arranged in a strongly made box with a cell collector on the inner lid, exactly as illustrated in Figs. 68 and 69, depicting the author's transportable dry-cell batteries for heavy currents. Such a battery is shown in Fig. 119 with a portable controller and meter in circuit, though if the cell-collector is of the cell-to-cell type the controller is not absolutely needed. Medium-sized cells permit as many as forty to be placed in one box without unduly weighting it, a forty-point switch then being necessary; but, for the physician who contemplates heavy current cataphoresis, eighty of the large cells, twenty in a box, should be ordered at once, as the special batteries described at page 212 are, of course, equally applicable to ordinary work as well as cancer treatment, one purchase covering both needs, as well as securing cells of greater lasting qualities.

---

[1] "Advanced Therapeutics," January, 1904, page 61.

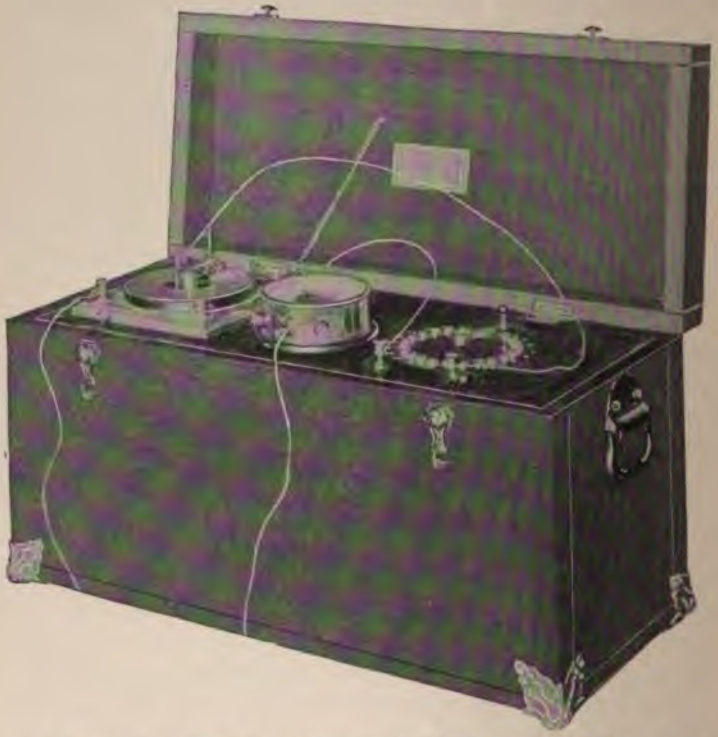


Fig. 119.—Author's Portable Dry-Cell Battery, with Meter and Controller in Circuit. The cell-to-cell switch shown is liable to short-circuit cells if the lever rests on two buttons.

It should be remembered, also, that these portable batteries may be very conveniently made to do duty as permanent batteries in the office when not otherwise in use, by merely so placing them near the wall plate or switchboard that wires from their terminal binding posts may be carried to the inlet posts of the wall plates, the cells being turned on as required, or left permanently turned on at their switchboards and the mains leading from them treated as ordinary battery mains. The two or three batteries so used should, of course, be connected up in series, as shown diagrammatically in Fig. 116. But one set of cells is therefore needed for both office and bedside work.

The batteries should be tested from time to time, and new cells purchased for the more important work when the voltage falls to about 1 volt per cell from their normal 1.5 volts.

In revising this work for the present edition the author has thought it best to exclude all descriptions of acid batteries, for though these batteries have for many years permitted physicians to employ an effective current away from the office, their excessive troublesomeness has militated most seriously against the practice of electro-therapeutics, and their place is more than filled by the dry cells described. Should an acid battery be used by the physician, however, the directions for its care are summed up in the injunctions: keep the zincs well amalgamated; lift the elements out of the solution immediately after use; do not carry a charged battery in a vehicle, but send it empty and charge it after its arrival; do not expect an acid battery to remain in order unless constantly used.

The fluid, or electropoion solution, used in acid batteries should be made of bichromate of sodium, and not of the potassic salt, as the latter is liable to split both the carbons and the cells by a heavy deposit of chrome-alum crystals. An excellent formula is:—

Bichromate of sodium	1 pound.
Bisulphate of mercury	1 ounce.
Commercial sulphuric acid	1 quart.
Water	sufficient to make 1½ gallons.

Put the bichromate and bisulphate salts in an earthenware pitcher of one and one-half gallons' capacity; fill the pitcher half full of water and stir the mixture; pour the quart of acid in slowly, and then add enough water to make one and a half gallons. Allow the compound to cool before using. The purpose of the mercury salt is the maintenance of the amalgamation of the zincs.

Electrodes.—Electrodes for percutaneous and permucous applications of constant currents consist of an active and a dispersing electrode or pole, under the modern practice of considering the polarity rather than the direction of the current. The active electrodes vary in nature and form for each special application and are, therefore, fully described in the portion of this work relating to special affections and particular procedures.

The purpose of an application being usually the concentration of the current in or through a certain organ or set of organs with as little unpleasant sensations or actions elsewhere as possible, the rôle of the indifferent electrode is not only the mere completion of the circuit, but it should render the current-effect at this point as inactive as possible. This is done by increasing the surface of contact and by making the moist conducting joint (page 38) between the metal and the subdermic tissues as perfect as possible. It was the application of this principle in the construction of the abdominal clay pad by Apostoli that gave the present impetus to the use of strong currents in gynecology, as already noted.

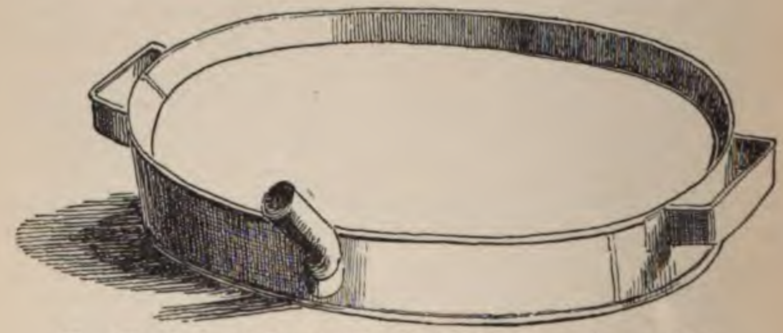


Fig. 120.—Jacketed Pan for Clay Pads. Hot water is poured into the interior through the pipe shown.

The Apostoli Clay Pad.—The clay for this purpose should be of the variety used by sculptors, or may be of pure kaolin, and should be kept in the consistence of soft mud by admixture with water in a covered crock. The pad may be made freshly for each application, or kept permanently made in a stout linen bag with tape handles sewn on, and is most comfortable to the patient when heated in a jacketed pan (Fig. 120) in the space between the double bottom and sides of which boiling water has been poured. When the pad is made up freshly at each application two layers of mosquito netting or a single layer of tarlatan should be spread out over the bottom, the material being large enough to reach beyond the edge of the pan to enable the clay to be lifted out after the pad is made by grasping its ends. The pad should be about an inch thick and of a sufficient size to cover the abdomen of the patient. After lowering it on the abdominal surface a block-tin or lead plate supplied with a binding post or socket for attachment of the cord is pressed down upon it. This plate is best shaped like a four-leaved clover and should be nearly as large as the pad.

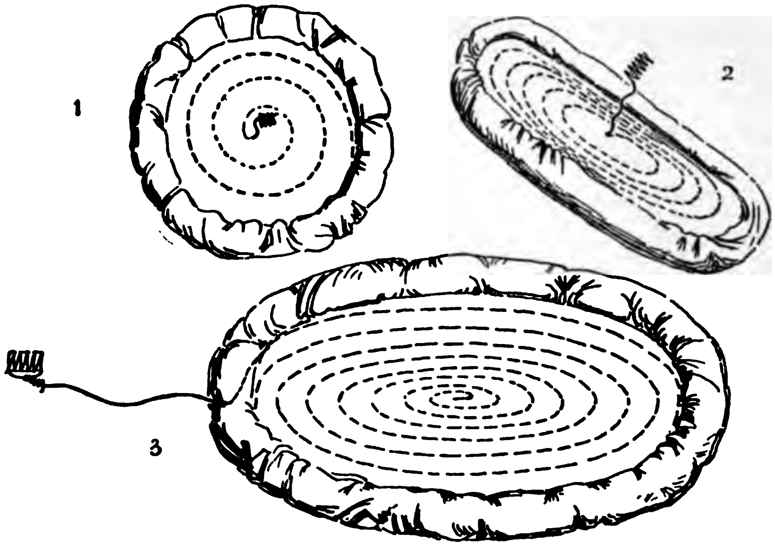


Fig. 121.—Author's Wired Cotton Electrode Pads. *1*, abdominal pad, for general use. *2*, spinal pad. *3*, large dispersing pad.

The Author's Wired Cotton Pads.—The most convenient pads for a dispersing electrode to be used on any part of the body are the author's wired cotton pads (Fig. 121), which are made in two or more sizes as follows: In the center of a piece of muslin somewhat larger than the intended pad the end of a spool of No. 20 soft, brass wire is sewn. The wire is then coiled in an increasing spiral and securely sewn in place on the muslin, each spiral being about half an inch from the preceding one, until the desired size is obtained, the shape being oval for the large pad and round for the smaller. When it has attained dimensions of about 7 by 11 inches for the larger and 6 inches for the smaller, a small turn is made in the wire which is then sewn down to prevent pulling out, and a considerable length of wire is left for connection with the battery. This free end should be at one extremity of the spiral for the large pad and in the center of the small one. Six or eight layers of absorbent cotton should now be cut to shape and piled on the wired side, and on top of the cotton a piece of muslin is placed to be folded over and sewn to the edge of the back of the pad. The pad should now be quilted lightly through and through to keep the cotton from packing, and when the end of the wire left free is made into a spiral friction socket for connection with a battery tip by winding it about the end of the tip, the electrode is complete.

Such pads are easily made by an intelligent nurse. They are wet with hot water and freely soaped with "Ivory" soap on the contact surface farthest from the wire when used. Before each subsequent use with a new patient they should be boiled for a few minutes.

The smaller round pad is most conveniently used as an active electrode in general applications (page 64) or as an indifferent pad for small currents.

While these pads are extremely convenient, the author prefers the clay pad for currents over 100 milliampères in strength, and particularly for use in the cancer applications.

CHAPTER XXVII.

EXPERIMENTAL HANDLING OF CONSTANT CURRENTS.

No ONE should apply an electric current to a patient without having previously familiarized himself somewhat with its practical management; and it is best for the beginner to emphasize the lessons thus gained by a moderate demonstration of the sensory effects on his person. With the battery set up or put in operation, the meter and controller being in circuit, the small electrode disks and cords may be attached to the binding posts for the following experiments:—

To Test for Current (Experiment 2).—Set the controller for least current (in the graphite controller with the crank on the beginning of the pencil-mark at the upper right-hand side), and bring the brass parts of the electrodes together. The meter will show a deflection of a greater or less number of milliampères. If there is no deflection a break exists in some part of the circuit.

To Test the Power of the Battery and the Range of the Controller (Experiment 3).—Unite the poles directly by means of a conducting cord or wire, and note the gradual increase in the current as the crank is moved toward the thicker graphite. This procedure is wasteful of battery power, but will show the total capacity of the battery through these resistances, if the meter registers high enough. With the incandescent current the increase should not be above the capacity of the meter.

To Test the Polarity of the Electrodes (Experiment 4). — If in doubt as to which is the negative pole and which the positive pole of a constant current battery or pair of incandescent terminals, place the tips of the cords in a solution of potassium iodide. The compound will be electrolyzed, iodine appearing at the positive pole as a brownish cloud, and potassium at the negative pole. If the potassium iodide be dissolved in starch-water, the discoloration at the positive pole is blue instead of brown, the nascent iodine immediately uniting with the starch. A more quickly performed test than this is to ascertain which tip gives off the greatest amount of gas when immersed in saline water, the negative possessing this distinction on account of the hydrogen-gas given off at its surface being double the volume of oxygen at the positive. The negative pole also gives the most sensation when suddenly brought in moist contact with a sensitive nerve in the hand between the thumb and forefinger.

Comparison of Metallic Contact with Moist Cotton to Cotton Conduction (Experiment 5).—*Having set the controller for a weak current,* note the number of milliampères in circuit when the brass surfaces of the two electrodes are brought together, and the number when the two wet surfaces of cotton or sponge are pressed together.

This will show the immensely greater conductivity of brass. As the current is not intended to go right back to the battery in this manner during ordinary work, it is called "short circuiting," and is wasteful of the battery power and dangerous to the delicacy of the meter.

Application of Dry Metallic Electrodes to Skin Compared with that of Wet Electrodes (Experiment 6).—Experiment now with the dry metallic surfaces of the little electrodes pressed down upon dry skin surfaces. Little or no current will be shown by the meter if the skin is free from moisture, even with the controller set for full strength. Substitute wet cotton-covered electrodes for the dry ones, and a current will be shown both by the sensations and the meter.

The current passes with exceeding ease from metal to metal when in contact, either dry or wet; but passes from dry metal to the body with difficulty. This is because the cuticle is practically a nonconductor; not until the air-spaces of its horny layers are filled with water, which is a reasonably good conductor, will it permit the current to penetrate to the more moist tissues below, and even then the bulk of the current passes through the sweat-ducts and any congested or abraded spots. Electrode coverings are therefore designed merely to hold a layer of water between the metallic surface and the skin, acting as a conducting-joint.

In making the experiment just detailed with dry metallic points instead of a flat surface, an intense burning sensation will soon develop if the full number of cells are used and the points well pressed down. This burning coincides with the appearance of some current in the circuit, as shown by the meter; but the number of milliampères by no means corresponds with the intensity of the burning; very little current passes, in fact, when the pain is greatest. This pain of the "constant current brush" is usually described as due to the concentrated action of the minute current quantities upon the most superficial and sensitive nerve-filaments; but doubtless the real reason is the microscopic spark leaps through the cuticle incident to this mode of current transmission.

Effect Produced on the Current-volume by Salt Water on the Electrodes (Experiment 7).—Set the controller at a given place and leave it there (or use the full strength of a certain number of cells), and note the number of milliampères passing through the hand when both wet electrodes are pressed upon opposite sides; leaving the battery-strength undisturbed, remove the electrodes and saturate them with salt water. When they are replaced, a considerable increase in the number of milliampères passing through the hand will be found. The sensations will be still more acutely increased.

Saturated salt water is about three thousand times a better conductor than distilled water; hence the use of salted water on electrodes increases the current by lessening the resistance offered by the conducting-joint at the points of entrance into and egress from the body. It is of great service when the battery power is deficient or accidentally low; but its constant use is inadvisable, owing to the disproportionate increase of pain produced by it and the bad effect upon the electrodes, which are quickly oxidized. The excess of pain is doubtless due to the irritant effects of the products of the decomposed chloride of sodium.

Effect upon the Current of Different-Sized Electrodes (Experiment 8).—Note the number of milliampères passing through a part of the body from the full strength of fifteen cells,—(1) when two small electrodes are used; (2) when two medium ones are used; (3) when two large ones are used,—care being observed to place them in the same spots and press their whole surface in contact.

If it is more convenient to use all the cells in the way advised generally in this work, instead of using the full strength of only fifteen, it may be done by simply setting the controller for a comfortable current with the small electrodes, and leaving it untouched in the subsequent steps of the experiment.

The increase of current when the larger electrodes are used is exceedingly striking. The cuticle, as has been explained, is the chief obstacle to the current; and from a given number of cells but a certain quantity can be forced through each square inch of its surface. The more square inches are included in the conducting surface, therefore, the more current will go through from the given number of cells; but there will be no increase in (and possibly a slight diminution of) the number of milliampères passing through the original square inch of skin, unless the number of cells is increased or the resistance of the controller lessened. The use of broad electrodes is indicated, therefore, whenever we wish to introduce a large current into the body with a minimum of pain and without a special concentration at the points of entry. It is the only way to affect deep structures by percutaneous transmission without excessive pain, and for such purposes both electrodes are large. In gynecic work, where the effect of a single "active" pole is alone desired, the other "indifferent" pole is made sufficiently large to secure easy penetration without such local action.

Comparison of the Effect of the Same Current-strength when Concentrated and Diffused (Experiment 9).—Connect the body with the positive pole of the battery by means of a large moistened electrode on its surface. This will form the indifferent pole. 1. Select an equally large moistened electrode for the active pole; place it on another part of the body; connect it with the negative terminal of the battery, and bring the current up to, say, 8 milliampères, as shown in the meter. Note the slight pain produced. 2. Exchange the large active pole for a medium-sized one, moistened of course, and bring the current up to the 8 milliampères. The pain will be increased, owing to the concentrated action of the same number of milliampères. 3. Use next a fine point as active pole, well covered with moist cotton, and again bring up the current to 8 milliampères. The pain is quite decided.

As the size of the active pole is diminished, the current being kept the same by adjusting the controller, there is an increase in the intensity of the pain corresponding to the increased density at this spot. The indifferent pole is left large in this experiment, as in so many gynecic applications, because it combines a slight resistance to the current with the least local pain. The experiment illustrates admirably the axiom that more force is required to get the same-sized current through a small place than through a large one,—a principle that applies self-evidently to most things.

Increase of pain accompanies with great certainty an increasing concentration of a given number of milliampères on the skin surface; but it should not be forgotten that this is because of the peculiar sensibility with which the body-sheath is endowed. Beneath it and in the interior of less sensitive cavities there is no such admonition to guide us; hence the use of a meter becomes more imperative in the latter situations, for the current is just as active whether pain is felt or not. It is only at and near the junction of mucous membrane with the skin surface, such as the lips, vulva, etc., that great sensitiveness to currents exists; and here it is even more sensitive than on the skin surface, in accordance with a fuller endowment of sensitive nerve-filaments.

Differing Resistances of Skin Surfaces (Experiment 10).—The differences in the resistance offered by the skin of various parts of the body, and of different persons, is readily shown by the effect on the meter at each position, the battery and controller being left undisturbed. The face, inner surface of the limbs, etc., will show more current (presenting less resistance); while the back and outer surfaces of the limbs will show less current (presenting more resistance), etc.

That these differences depend almost entirely on varying thicknesses of cuticle is proven by the showing of more current with the poles on distant, but thin, spots than when alongside of each other on thicker cuticle. The difference between corresponding parts of the skin of different individuals is also at times considerable, especially when a clear-skinned blonde and pallid brunette are compared.

Comparison of the Resistance of Skin and Mucous Membrane (Experiment 11).—Connect but a small number of cells, say fifteen, with the meter and controller, in order that the full strength of that number of cells may be used. Having put the indifferent pole on the abdomen or back, cover an insulated stemmed vaginal electrode with absorbent cotton, wet it, and direct the subject of the experiment to hold it between the bare arm and chest in such a manner that the whole conducting surface is in contact, as it would be in the vagina. Turn the current on gradually now to its full extent by means of the controller, and note the number of milliampères. Reverse the controller until there is no current, and introduce the electrode into the vagina. The current may then be again increased by the controller to its full capacity, and the number of milliampères noted in this situation.

A marked increase in the milliampères will be noted in the vagino-abdominal circuit over the merely percutaneous one, on account of the lessened resistance encountered at the active pole when placed in contact with mucous membrane.

Alteration of Nerve Irritability Within each Polar Region (Experiment 12).—Attach two medium-sized electrodes of the same dimensions to the binding posts, place them (well wetted) on the skin over each peroneal nerve just back of the head of the fibula, and increase the current to 5 or 10 milliampères.

The burning pain under the negative electrode is in distinct contrast to the numb sensation under the positive.

The Effect on Nerves of a Slowly Varied or Continuous Current Compared with that of a Sudden Current Variation (Experiment 13).—Proceed as in Experiment 12, noting that no pain or motion is produced in the distant parts of the nerve if the 5 or 10 milliampères have been attained by a *gradual* increase from zero. With the current at this height remove now one of the electrodes and reapply it (or break and make the circuit by an interrupter),—a contraction will be produced in the muscle supplied by the motor fibers, and a sudden sensation in the areas supplied by the sensory fibers of the nerves.

The actual performance of these and similar experiments is unequaled in its teaching power. Besides familiarizing one with many details essential to successful work with the continuous current,—such as the necessity of always using a meter; the possibility of avoiding shock, even with powerful currents; the advantage of ample battery force held in easy check by a controller; and the wisdom of using large and small electrodes as we wish deep or local effects,—it will show that the practice of electro-therapeutics, while relieved of many unnecessary and obsolete theories, may still remain free from the formidable task still imposed by some recent writers, who recommend that the resistance of the tissues be calculated and recorded in each case. As well might they say that we should measure the darkness in a room rather than the light produced in the effort to dispel it; in the one case the photometer and in the other the milliampère-meter are all-sufficient to convey full information for practical purposes.

To Locate Faults in the Circuit.—Should a battery fail to give a current when the electrodes are in position and the current turned on at the controller, turn the handle of the latter off at once, to avoid shock when the fault is located. The fault may then be localized by holding the cord tips in contact, turning the controller on slightly and examining the circuit backward to the cells as follows: First note that the binding posts are tight; then if either cord is unbroken, by short-circuiting the treatment poles with each cord in turn, and watching for deflection of meter; if still no current appears, touch the inlet binding posts of the apparatus with moistened fingers, noting a slight sensation if the circuit back to the batteries is complete; if no current is then detected the trouble is most likely in the cells of the battery. The cells are easily tested by using a cheap meter (since an expensive one has too little resistance for the short-circuiting necessary) as follows: Attach two wires to the meter, one of which is connected with the first carbon or last zinc; with the other wire touch the zincs backward through the battery at haphazard, obtaining a full deflection until the break has been passed, when the actual spot can be easily located. After correction, test the whole battery for other faults in the same way.

CHAPTER XXVIII.

THE MAGNETIC INDUCTION CURRENT.

Mode in which Magnetic Induction Currents are Produced.—Induction currents are isolated rises of pressure in a wire, produced at the moment of breaking or making the direct current of a cell which circulates in its immediate neighborhood. This current was called faradic after Michael Faraday, who first discovered that a current would be so produced in a closed-wire circuit placed over or close to another in which a constant current was varied, but the name has recently been abandoned in the interest of accuracy and universality of nomenclature at the suggestion of the Committee on Current Classification and Nomenclature of the American Electro-Therapeutic Association in its 1903 report.[1] The strength of a current so produced is proportional to the strength of the producing current, plus the length of the wire subjected to the influence of the inducing current circuit; so that convenience necessitates the coiling of one insulated wire about the other, producing a solenoid, or induction coil, in which many feet of wire occupy but a small space. It is necessary that the two wires, carrying the inducing and induced currents, should be close to each other and properly insulated throughout. The action of the inducing current from the cell in the first coil is increased if a soft iron core be inserted within it, making what is called an electromagnet.

In a simple coil of but few turns, or in two straight wires placed close to each other, a current arises in one direction in the second wire on closing the cell-circuit in the first, and another current arises in the other direction on opening the cell-circuit. The current that appears in the secondary coil at opening the cell-circuit in the primary is direct, or in the same direction as the cell-current, while the current that appears in the secondary at the moment of closing the cell-circuit is inverse. The primitive magnetic induction current is, in other words, a to-and-fro, or alternating, current. In the batteries we use this is also true of the currents from the secondary coil, though, for reasons to be shown, only the direct currents are therapeutically important. An equal electromotive force and an equal volume arise in each direction, causing an equal amount of electrolysis (which is thus continuously neutralized), yet the therapeutic effects are very different on account of the greater abruptness of potential rise in the direct current; and as the only purpose for which induction currents are used in medicine is the muscle- and nerve- stimulation or sedation that a minute current can produce when very suddenly developed, the primary and secondary currents of opening are practically the only utilizable portions of the induction.[1]

---

[1] Recognizing the unwisdom of the employment by physicians of terms for electric modalities that are not understood by physicists and electric engineers, the author has eliminated the terms "galvanic" and "faradic" from the present edition of this work, so far as practicable, substituting "constant current" and "induction current," respectively.

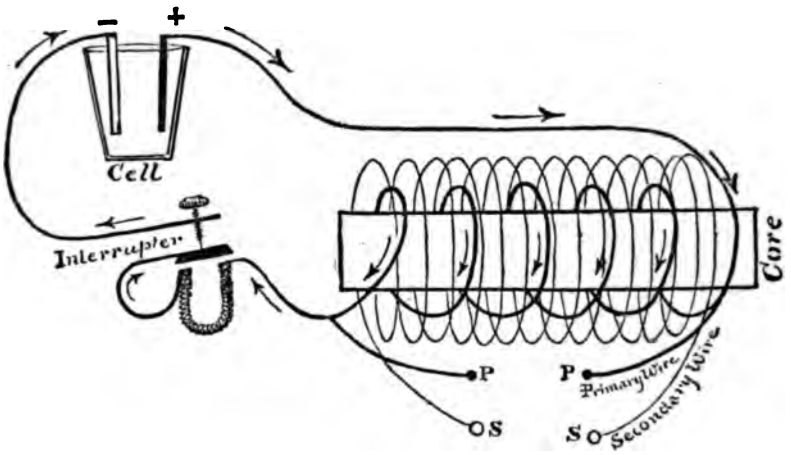


Fig. 122.—Diagram of Induction Battery.

An induction battery (Fig. 122) consists essentially of one or more cells placed in circuit with a primary insulated wire surrounding the core, and with an automatic device alternately to break and make the cell-current. Over the primary coil is slipped a bobbin having another coil of insulated wire wound about it. This second, or secondary, coil has no metallic connection with the cell or the cell-current, deriving its current by induction because of being placed over and close to the primary coil and core. The operation of the apparatus is as follows:—

---

[1] The direct current of opening is formed and completed in 0.000275 second, while the inverse current of closure requires 0.000485 second.

The cell-current, proceeding from the carbon pole of the cell, traverses the primary coil and returns to the cell through the interrupter, the platinum points of the latter being in contact. In the act of traversing the coil this current makes the core magnetic, which in turn attracts the small armature on the interrupter, breaking the cell-current; the magnetism of the core having now disappeared, the spring returns to contact, when the whole process is repeated. The rapidity of this automatic action depends on many factors that will be referred to later. At the instant of closure of the cell-current a reverse induction arises in the secondary coil, but this rises slowly on account of what is called self-induction between contiguous windings of the primary coil. At the instant of opening the cell-current a direct current arises in the secondary coil of much sharper curve of ascent (because there is but little self-induction to interfere with it).

No currents arise in the secondary coil unless its ends are closed by a patient or other conductor at *S-S.*

Recurring to the primary coil, it will be noticed, by reference to the figure, that the patient, when connected by electrodes with the primary binding posts *(P-P)* is placed in what is known as a "shunt," or parallel circuit with the primary coil. This permits an infinitesimal amount of the cell-current to traverse the tissues when the spring is in contact; but since the resistance of the coil is less than an ohm and that of the patient some hundreds of ohms it will be seen that practically all of the cell-current will take the short road through the coil instead of going through the patient. At the moment of closure of the cell-current a reverse current does arise in the primary coil by self-induction, but this never reaches the patient, being expended, as already stated, in blunting the sharpness of rise of pressure in the cell-current at closure. When the cell-current is opened at the interrupter, however, the primary direct induction arising in the primary coil has no recourse but to traverse the patient placed in connection with the binding posts at *P-P.* This induced current of opening, known among electricians as an "extra current," is the medical primary current, and gets much of its force from the demagnetization of the core; and, since it is produced in a coil nearer the core than any secondary wire can be, the volume of the current may be greater, other factors remaining the same. The direct inductions only can reach the patient, the inverse inductions being neutralized by the cell-current. *The primary current is, therefore, not in any sense an alternating current.*

Means of Controlling Induction Currents.—In the sledge or du Bois-Reymond apparatus, which is the one found in the best modern apparatus and in the large cabinets, and is decidedly the best form, the secondary coil is made to slide over the primary, the inductions in the secondary gradually strengthening as the secondary windings are more and more subjected to the influence of the cell-current in the primary coil and of the core. To slide the secondary slowly over the primary is, therefore, a method of turning the secondary current on, and to slide it off a method of turning it off. The reverse is true of the primary current, which is weakest when the secondary completely covers the primary, and is increased by uncovering it. The secondary coil thus acts as a damper on the primary,[1] abstracting the inductions to itself. An old form of Duchenne's apparatus provided for controlling the current by covering both coils with a tube, which, when a complete cylinder, dampened the inductions in both coils and core by permitting circular inductions around its own circumference. The cheaper portable apparatus of the present day accomplish the same regulation by a sliding cylinder covering the core only, but both methods of regulating with cylinders have the disadvantage of not reducing the currents to zero, leaving a slight shock when the circuit is closed with weakest current.

The most convenient method of regulating or controlling induction currents is by setting the coils at the position for the greatest current of the kind required, and then passing the current through the same controller employed with the constant current, which will be found to answer perfectly. This method is invariably followed by the author.

---

[1] The secondary coil would not have this damping effect on the primary were it not that an automatic arrangement closes its ends for this purpose, making it practically a tube.

Though so-called faradometers have been both promised and constructed, there has been no way devised to measure induction currents actually traversing the patient, owing to their slight volume and short duration. Arbitrary records of position of coils are employed for comparison, while therapeutic dosage is governed mainly by the effects obtained.

The Cell and Cell-current.—From one to three commercial dry cells are usually sufficient to operate the coils, a greater number being required at times with the long wire coils. If an acid cell is used, the zincs should be kept in order and brightly amalgamated and the solution fresh, as the work of these cells is heavy, uniformity of interrupter action and full induction requiring that about half an ampère should circulate through the primary coil. Since the circuit is all metallic outside the cell, with an external resistance less than an ohm, one or two good cells will suffice unless they are placed at a distance from the apparatus, when the additional length of wire will necessitate more.

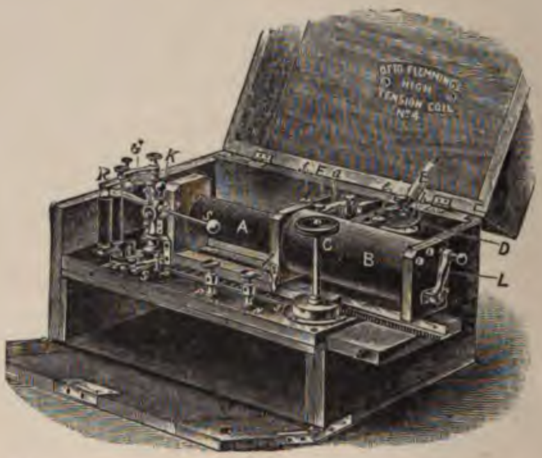


Fig. 123.—Flemming's No. 4 Induction Battery, Possessing a High-Tension Coil and Excellent Primary, Controlled by the du Bois-Reymond Slide.

The Primary Coil and Core.—The proper construction of induction coils was recently the subject of much discussion in electro-therapeutic circles, a standing committee having been appointed by the American Electro-Therapeutic Association to conduct investigations, and while it is beyond the scope of this work to enter into technical discussions that would be too voluminous for its pages, the considerable importance of these currents in gynecology necessitates a succinct statement of the features that are at present thought to be essential in a properly constructed gynecic apparatus. It is too true, as stated by Goelet and Engelmann, that the great majority of physicians have purchased, and are still purchasing, apparatus that is practically worthless for gynecic purposes. Even much of the best apparatus recommended by these authors has too small a primary coil and core to give a really powerful contracting primary currrent. The most useful size of primary coil, in the author's experience, is that usually found in the Flemming No. 4 induction battery and his cabinet apparatus. The dimensions are: length of core, $5\,{}^{1}/_{2}$ inches; thickness of core, ${}^{5}/_{8}$ inch; the primary coil contains 120 feet of No. 18 copper wire, wound in four windings. The resistance of the coil is ${}^{8}/_{10}$ ohm. Frank S.

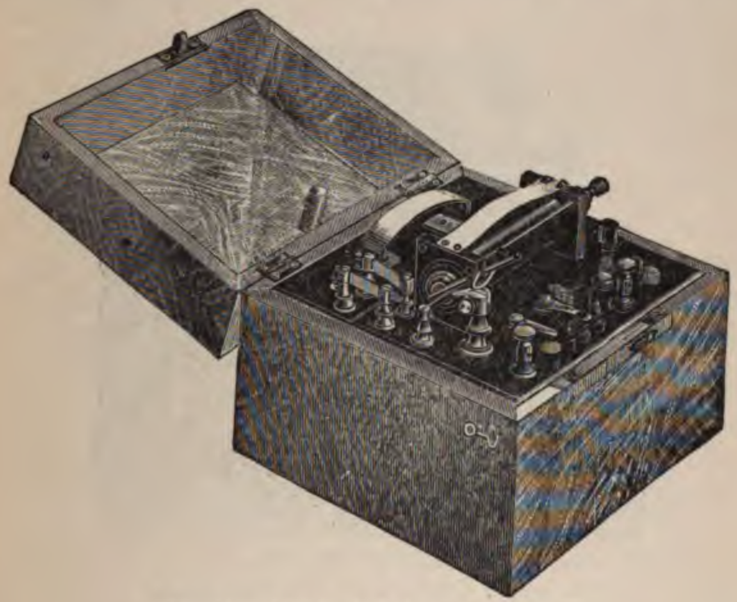


Fig. 124.—McIntosh Induction Battery.

Betz & Co. have recently adopted these dimensions. It is likely that these proportions are nearly correct, as no additional contracting power was gained in several experimental coils operated with cells, either by doubling the length of core and coil or by changes in the size or length of the wire, though much stronger currents may be obtained when longer coils are operated by the 110-volt current with a 32-candle lamp in series.

Primary Current.—Since the primary coil is made of a comparatively short thick wire, permitting of but few turns about the core, the electromotive force developed in it is not nearly so high as in the secondary coil. Its nearness to the core results in heavy ampèrage in comparison to the latter coil, however, which is rendered greater by the slight resistance of the short, thick wire. In regulating it with the Massey controller the secondary coil is removed all the way, or to the greatest extent desired, and the controller turned on until a sufficient contraction is obtained. Owing to the low pressure, it will be noted, no current is felt until the controller is half-turned on, but the current increases with augmented rapidity as the end of the graphite area is reached. The converse is true with the high-pressure

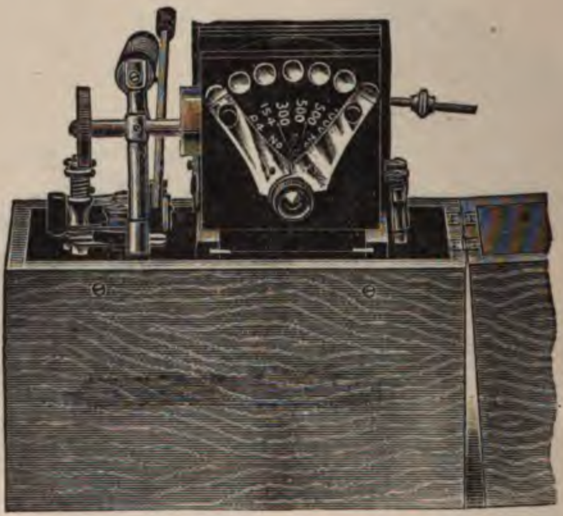


Fig. 125.—End View of Rockwell's High-Tension Coil, as made by the Jerome Kidder Manufacturing Company.

currents of the secondary coil, most care being required to make the increase gradual at the beginning of the graphite area.

Uses.—The primary current is indicated whenever we wish to produce fullest contractions of muscular tissue, whether striated or unstriated, provided the total resistance of the circuit is not great. When applied through externally placed electrodes, therefore, we must use large, well-moistened pads, and, if it be monopolar, the indifferent pad must be large. It is particularly adapted to bipolar work, owing to the small resistance between the electrode surfaces, and is indicated in recent subinvolution and in atonic conditions of the bowels and bladder.

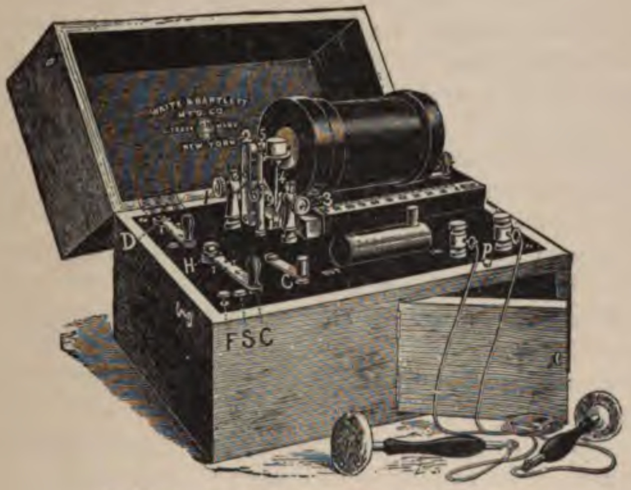


Fig. 126.—Engelmann's Induction Battery.

The Secondary Coil and Current.—As already stated, the secondary coil must be made of a long, fine wire if a considerable electromotive force (as yet not accurately measured) is to be developed for use in producing sensory and vascular sedation. Currents from very long wires are best for use in conditions of semi-acute irritation, when rapidly successive inductions of high pressure and extremely small volume only are bearable. As a condition of greater tolerance is established a more distinctly contractile current will give increased curative effects; hence an instrument for gynecic use should have several interchangeable secondary coils to choose from, the coil adapted to the case being slipped over the primary as required. The earliest effort in this direction in this country was the portable induction apparatus of the late Dr. George J. Engelmann, formerly of St. Louis, in which three secondary coils were used.

The Engelmann Coils.—No. 1, coarse-wire coil, is made of No. 16 wire, about 225 feet long. This is used for motor stimulation, though a good primary coil will do better work of a similar kind.

No. 2; intermediate coil. This is made of No. 21 wire, about 675 feet long, and produces less painful contractions.

No. 3; fine-wire coil. This is made of No. 31 wire, 1980 feet long, and the effect is moderately sedative.

The Goelet Coils.—Owing to the possibility of obtaining greater sedation by a still longer wire in the fine coil, Dr. A. H. Goelet, of New York, has introduced a set of three coils of still greater elaboration, the two fine spools having switches on the end, permitting of the tapping and using of different lengths of wire from the same coil. They are constructed as follows:—

Coarse coil, No. 22 wire, 750 feet long (this is unnecessary, the primary coil fulfilling the indications).

Intermediate coil, No. 32 wire, 2400 feet long, tapped at 1600 feet and 900 feet.

Fine coil, No. 36 wire, 4500 feet long, tapped at 3000 and 1500 feet.

The Goelet coils, when supplied with a properly made primary coil and core, leave nothing to be desired in their adaptation to the most varied therapeutic indications. When using them, the switch at the end of the bobbin should be placed on the point marked with the coil-length that it is wished to employ in the case.

The Interrupter, or Rheotome.—This is a most important part of a good gynecic apparatus and is unfortunately seldom what it should be. I am convinced that the simple vibrating spring-hammer of Neef, which is the kind usually found on even the best batteries, should be abandoned entirely in favor of what I have called the bowstring interrupter of Flemming, or else of the "singing rheotome" of Van Houten & Ten Broeck. The bowstring interrupter is simply an extension of the spring to double its length, both ends being attached to posts, to one of which a tension-screw is attached to increase or lessen the tension of the spring and thus regulate the time of the vibrations. The armature is attached to the middle of the brass spring and the platinum plate for contact near the fixed post. Besides regulating the frequency and amplitude of the vibrations by the tension-screw, we regulate them also with the set-screw carrying the platinum contact-point. This device gives easily the rate of vibration suitable for muscular contraction, which is from 1 to about 3000 per minute, and this rate serves well for sensory sedation if the fine coils are used. According to d'Arsonval, the highest stimulation may be obtained from a suitable coil between 3000 and 4000 interruptions per minute, the stimulation decreasing with a further increase of the rate until with 7000 to 9000 interruptions of a medium current it is no longer felt. Vibrations above 3000 per minute are therefore sedative rather than stimulating, the separate excitations of muscle and nerve blending together, muscular excitation finally ceasing, and the sensory excitation changing into a numbness.

There is no really practical means of measuring the rate of vibration of springs, however, the low or high note emitted by them being the most convenient method of approximate estimation. Regularity of rate, with consequent regularity of current rise and fall, is particularly essential, not only in sedation with high-frequency currents, but for painless contraction; hence a spring that gives a confused or jarring note should be discarded for one that can be adjusted and maintained to a clear note, whether low or high. With all springs, however, there seems to be an unfortunate liability to sudden changes when the relative position of the coils is changed during a *séance*. To avoid this change of vibrator note (which is apt to be slightly disagreeable to the patient) it will be well to discard overused cells promptly and thus keep the driving power uniform, and employ the graphite controller as the means of regulating the strength of the current instead of moving the coils.

Combined Constant and Induction Currents.—There are times when it is desirable to apply both constant and induction currents simultaneously in abdomino-dorsal and vagino-abdominal applications, both to save time and to obtain an intensifying effect. The practicability of this was first shown by de Watteville, of England, who devised the series of switches for this purpose shown in Fig. 127. It may be accomplished in an off-hand manner by simply connecting, say, the positive binding post of the constant apparatus with the negative binding post of the induction apparatus; the unconnected binding posts will then be the poles of the combined currents. Both currents may then be controlled by the same controller, as shown in the diagram (Fig. 115), which indicates the proper manner of permanently wiring a table-plate or wall-plate in which either the constant current or the induction current, or both currents combined, may be turned on at will. If the street mains be used in the apparatus for the constant current, the same supply cannot be used to run the induction coil also, but separate cells must be used to run the coil.

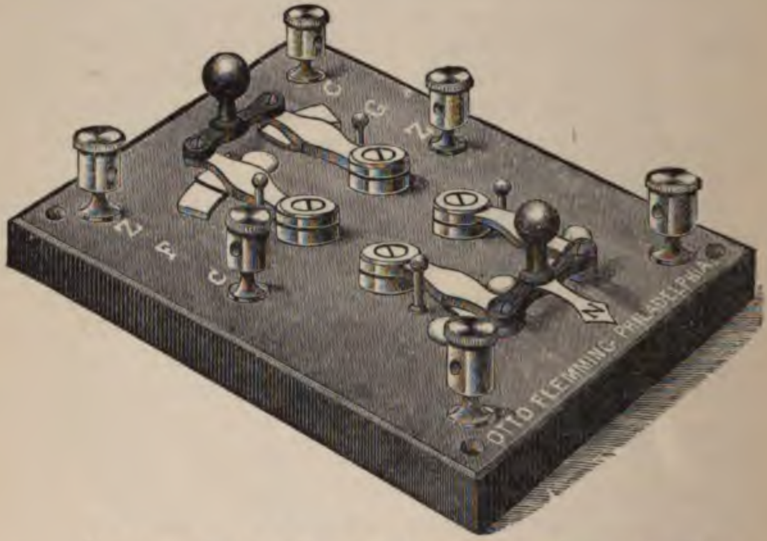


Fig. 127.—The de Watteville Combiner, for Simultaneous Administration of Constant and Induction Currents. This apparatus is not required when the cabinet or wall plate is wired as shown in Fig. 115.

Polarity of the Induction Current.—The primary current of an induction coil has as distinct a polarity as the constant current, being always in one direction, as explained above. The secondary currents have also a distinct polarity in their physiologic action, though not so marked as is the primary, the direct inductions being stronger and more abruptly produced than the inverse inductions. The electrode attached to the negative pole of either current will, therefore, be found to be the most stimulating when applied to nerves and muscles, and the positive most sedative.

Indications for the Use of Covered and Bare Electrodes with Induction Currents.—The use of a moist conductor to convey the induction current *through the skin* to nerves and muscles beneath it is fully as important as in the case of the constant current; for, although the former current leaps from a dry metallic disk to the skin with great facility, and is therefore best adapted to the dry-brush method of stimulation, it expends its action at such times almost entirely on the dermic surface and nerve-ends, the polar region being extremely superficial. The moist covering permits a greater penetration and extension of this region; hence, a deeper action with less surface pain. Within moist cavities, however, the use of a moistened covering on the exposed conducting surface of the electrode is totally unnecessary, as the moisture of the cavity itself readily favors this distribution of the current. The bare electrode is, moreover, introduced into such cavities with greater ease. The handles of such electrodes should, of course, be properly insulated, to protect the vulva and other parts not designed to be affected.

Experimental Comparison of the Electromotive Force, or "Pressure," of the Induction Current with that of the Constant Current (Experiment 14).—This may be roughly done by touching simultaneously, with dry fingers, the bare terminal wires of a full-strength constant battery. No current is felt, since the sixty to ninety volts of pressure in such a constant current are not sufficient to make the current jump through the minute layer of air between the finger and the wire; moist fingers permit a little to get through. If, now, the dry fingers be simultaneously brought in contact with the bare terminals of an induction current apparatus of merely medium strength considerable tingling will result; its pressure is amply sufficient to cause it to leap through this air-space.

There are two practical applications of this fact besides its demonstration of the main quality of electromotive pressure: one indicates the need of a more careful insulation of the induction current to prevent accidental shocks; and the other, the greater adaptability of this current for the electrical brush application to the body-surface.

Action of the Induction Current on Sensory Nerves and Muscles.—Notwithstanding the exceeding weakness of this current in "bulk" or "volume," the great requisite for usefulness in the mechanic arts and in the chemic destruction and metamorphosis of tissue, a slight acquaintance with its action on any part of the body is apt to impart an exaggerated idea of its physiologic powers. Being essentially a series of exceedingly abrupt current creations, its power to excite the functions of nerves and muscles is unique, and the manifest phenomena of pain and muscular contraction conceal its total inability to produce profounder impressions on the body. A nerve or muscle, brought within either polar region, is thrown into action as each induction arises, just as an abrupt variation of the constant current, whether a rise or fall, produces a similar phenomenon. Each induction produces a separate stimulus, therefore, and it is only when they follow each other very rapidly, as when a rapid interrupter is used, that the separate stimulations seem to blend together, producing a continuous contraction or sensation. Even then the impressions on the nerve are those of distinctly separated, though rapidly successive, currents. The sedative effect produced by high-frequency currents from the fine coil is probably of the nature of a temporary anesthesia of the terminal sensory apparatus.

The susceptibility of the sensory nerves of the limbs and trunk to the induction current is fully shared by those of the pelvis, although the lessened sensibility of the normal uterine and ovarian nerves permits the employment of current-strengths not bearable on the skin surface. The vulva, on the contrary, like other muco-epidermic junctions, is exquisitely sensitive to this stimulus, and should be protected from it in all ordinary applications by well-insulated electrode stems. The sensibility of the vagina is about midway between the two.

Therapeutic Uses.—This current acts only on nerves and muscles, stimulating each into action or developing anesthetic effects, and its use is, therefore, limited strictly to such conditions as exhibit nervous or muscular laxity or pain. But is this limitation a very narrow one? How many of the commoner cases met in daily practice present just these shortcomings, especially those encountered in a public clinic? The case after case of displaced and prolapsed uteri that present themselves, with or without rectocele or vesicocele, and with intact perinei, teach the paramount importance of muscular tone of the vaginal walls and uterine ligaments in the maintenance of a normal condition. When this tone has been lost, it is evidently the part of rational medicine to endeavor to restore it, if possible,—not to prolong and intensify it by erecting a false skeleton with a pessary or tampon within the vagina.

Properly constructed bipolar electrodes are peculiarly efficient in attaining this contractile action on relaxed pelvic muscles, inclusive of the uterus itself. Bipolar vaginal applications may be made with the coarse-wire coil or primary current if there is no inflammatory condition, but if such is present the pain and violent contractions produced by these currents are capable of increasing the mischief. The combination of mild contractile and anesthetic effects obtained from a similar use of fine-wire currents is, on the contrary, most beneficial, even in subacute inflammation; hence bipolar fine-wire currents are useful in a large number of cases, the simple anesthetic effects rendering them invaluable in either inflammatory or non-inflammatory neuralgias.

Electrodes and Dosage.—As a rule, the active electrodes required for constant current applications may be used for this current, and a similar dispersion of current at the indifferent pole is advisable when used after the monopolar method. The absorbent cotton pad will, of course, be more convenient than the clay if an induction current only is to be used.

The only electrodes peculiar to the induction current, and which should not be used with other currents, are the bipolar electrodes, of which the one for use within the vagina is the most commonly employed. Apostoli's bipolar vaginal electrode as modified by Goelet (Fig. 29) is decidedly the best. In this instrument the designer has adopted the bulbous projections suggested by me to make better contact with the mucous membrane, and has also altered the relative proportions in such a way that the instrument is practically self-sustaining within the vagina.

Apostoli's intra-uterine bipolar electrode (Fig. 35) remains the best in design, but all intra-uterine bipolar electrodes are clumsy and difficult to asepticize thoroughly.

The selection of the dose is purely empirical, as we have, at present, no means to measure this current beyond the individual scale of each instrument. The best guide to the strength required in a given case is gained from the sensations of the patient, the current having been brought up from zero to the point of easy tolerance, after placing the electrodes in position, in the same gradual manner as advised for constant current applications. If we do not shock by a sudden turning on or off, there is no possible way in which the patient can be harmed; so that our main point in muscular applications is to use as much current as the patient will bear without pain, and it is astonishing how much can be given in this way with one pole in the vagina or uterus and a large dispersion on the abdomen. Weaker currents are better for neuralgic conditions, as a rule. The milliampèremeter is, of course, useless with this current.

CHAPTER XXIX.

STATIC ELECTRICITY.

THE qualities and effects of static electricity have been studied more intelligently during the interval of time since the appearance of the last edition of this work than any other electric modality used by physicians (and possibly to the neglect of some), owing to the introduction of the wave-current by Dr. William J. Morton, and the high-frequency currents of d'Arsonval, and to the immense advance made in the application of x-rays to therapeutics and diagnosis, the latter being largely transformed from static currents. As a result we have volumes devoted to static electricity alone.[1] The scope of this work precludes the presentation of more than an introduction to the subject, and students are referred to these special treatises, particularly to that of Dr. Snow, for more complete discussions of this electric modality.

Physics.—Static electricity, unless transformed in some manner, is a unidirectional current of exceedingly high pressure and very slight volume. The latest and most valuable physical study of this current and its transformations is contained in the Report of the Committee of the American Electro-Therapeutic Association on Current Classification and Nomenclature for 1903.[2] Under the auspices of this committee, a member, Prof. Samuel Sheldon, of the Brooklyn Polytechnic Institute, made a careful study of the currents produced by two large Holtz machines. A needle gap was employed between the poles to secure a continuous discharge through the air when the poles were separated, with the following interesting results with a voltmeter and ammeter in circuit: With a machine having 10 rotating and 5 stationary plates:—

---

[1] "A Manual of Electro-static Modes of Application, Therapeutics, Radiography and Radiotherapy," Second Edition, by William Benham Snow. New York: A. L. Chatterton & Co. Also, "Static Electricity, X-Ray, and Electro-Vibration," by Franklin B. Gottschalk, T. Eisele, Chicago.

[2] See pamphlet report by W. J. Jenks, E.E., chairman, New York.

With poles in contact................	11	volts	0.000597	ampère
With poles separated 6 inches......	71,200	"	0.000482	"
With poles separated 12 inches......	122,000	"	0.000319	"
With poles separated 18 inches......	180,000	"	0.000194	"

This investigation shows the interesting fact that 11 volts and about $^{1}/_{2}$ milliampère was produced within the machine with the external poles touching, while in the position to do actual work, the voltage varied from 71,200 volts and less than $^{1}/_{2}$ milliampère with poles separated six inches, to 180,000 volts and about $^{1}/_{10}$ milliampère with the poles separated eighteen inches.

Dr. Sheldon also produced the electrolytic proof of the milliampèreage of these currents by causing it to decompose a solution of ammonium nitrate and chloride with the ferricyanide of potassium, a blue streak appearing in strips of blotting paper attached to one pole when a wire attached to the other was drawn across it.

With a current possessing such an infinitesimal volume it will be seen that the principal therapeutic effects are due to an inconceivably high polarization of nerve and muscle. When the spark is applied to the dry body it undoubtedly disrupts the cuticle on its way to the moist tissues that act as the surface of the conductor, the surface nerves of sensation receiving the brunt of the excitation; but if moist electrodes be employed, as first suggested by Morton, the spark is conveyed through the skin by conduction rather than disruption and deeper nerves and muscles are then readily reached, as with other currents. Since the volume of these currents is so slight, it is, of course, essential that an interruption of the current, or sparking space, must exit somewhere in the circuit with the patient for any action to be manifest, the completely closed external circuit giving us a continuous current of only $^{1}/_{2}$ milliampère which is practically nothing under the circumstances.

There is, however, another important physical effect produced by this form of electricity besides the polarization of nerve and muscle by transmitted currents. This is the static effect of the charge on the body-surface when sparks are not used. The equally diffused charge as in static electrization, and particularly the concentrated charge on the portion of the body opposite the electrode administering a spray, have peculiar and yet but imperfectly explained actions on nerves and tissues.

For a full explanation of the principles involved in the operation of a static, or influence, machine the reader is referred to Dr. Snow's complete work, already mentioned.

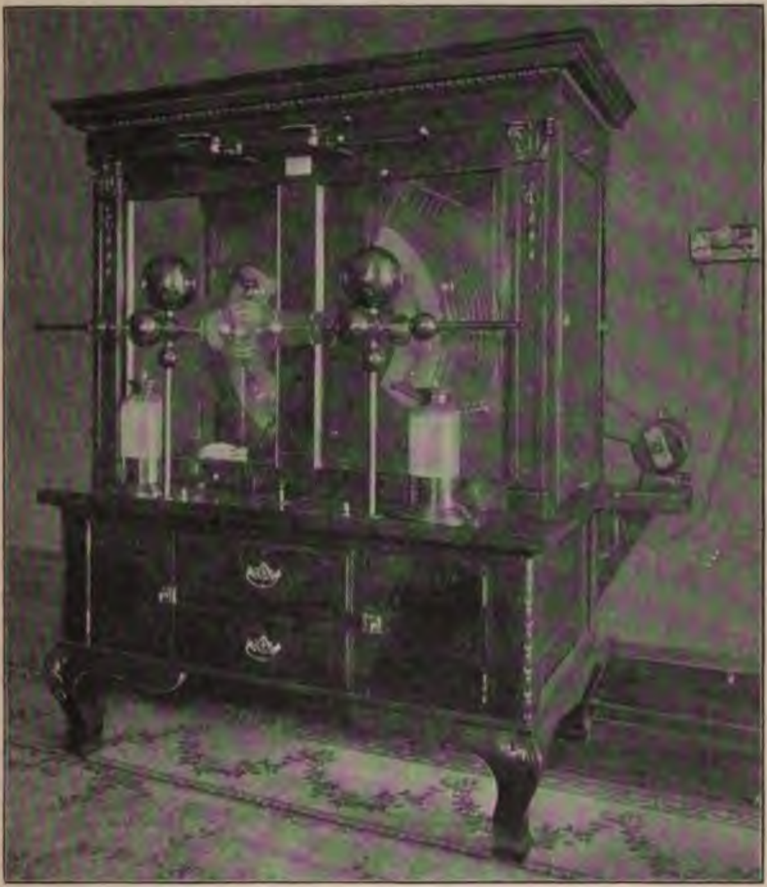


Fig. 128.—Betz Static Machine, with Twelve Revolving Plates. This machine is self-charging by reason of possessing two Toepler plates.

The machines now made on a large scale in America consist of two parts, the chief portion being a mere development of the Holtz machine, a German pattern in which the principle of induction was substituted for friction about 1865. The improvements on the original

Holtz pattern consist mainly in perfection of mechanical moving parts, multiplication of plates, and protection from atmospheric influences. A Holtz machine consists of stationary plates with paper elements and plain revolving plates. Both forms of plates are coated with varnish, and the whole, with its collecting combs, resembles a dynamo in effect, the stationary plates being analogous to the field magnets, the revolving plates analogous to the armatures, and the collecting combs, etc., resembling the commutators of the dynamo.

The Holtz pattern represents the most reliable form of construction for a large output of current, but easily loses the initial charge which it multiplies to a full load so readily. To overcome this difficulty (which it shares with the best dynamos, which often need a "charger"), American manufacturers resort to two expedients: the placing of a Wimshurst charger machine (consisting of two plates with many disks, moving in opposite directions) in the same case, and the use of Toepler's modification on the first and last plates. The former plan has the disadvantage of increasing the size of the case unduly, rendering it difficult to find room for the machine in a moderate-sized office. The Toepler modification (small disks on the first and last revolving plates, touching small brushes) renders a machine self-charging, and detracts in no way from the value of the Holtz pattern of the remaining plates, while insuring a continuous charge.

Selection and Care of the Static Machine.—The author has frequently been asked if a static machine is a necessary adjunct to an office outfit in the practice of neuro-gynecology. Though skeptical originally on this point himself, a long experience has convinced him that it is of far more relative importance than an induction outfit, though still far beneath the constant current apparatus in relative value. Comparisons are of but little moment in such matters, however, the indications for the use of each current being usually distinct and separable. No office is thoroughly equipped for good work without all three of these currents, aside from the value of the static machine in the production of x-rays.

In the selection of a machine it should be understood that the electromotive force of the current is determined by the diameter of the revolving plates and its volume by the number of these plates. Now, a most important form of treatment in neurasthenia and allied conditions is the static spray and static charge, and, while adequate sparks may be applied from machines of but moderate size, the former procedures demand that the machine shall possess at least eight *revolving* plates, while twelve revolving plates are even more desirable. More than the latter number may be of value to a specialist with more than one machine, but to an operator who wishes one instrument to do all of his work there is a distinct disadvantage in its possessing more than twelve revolving plates.

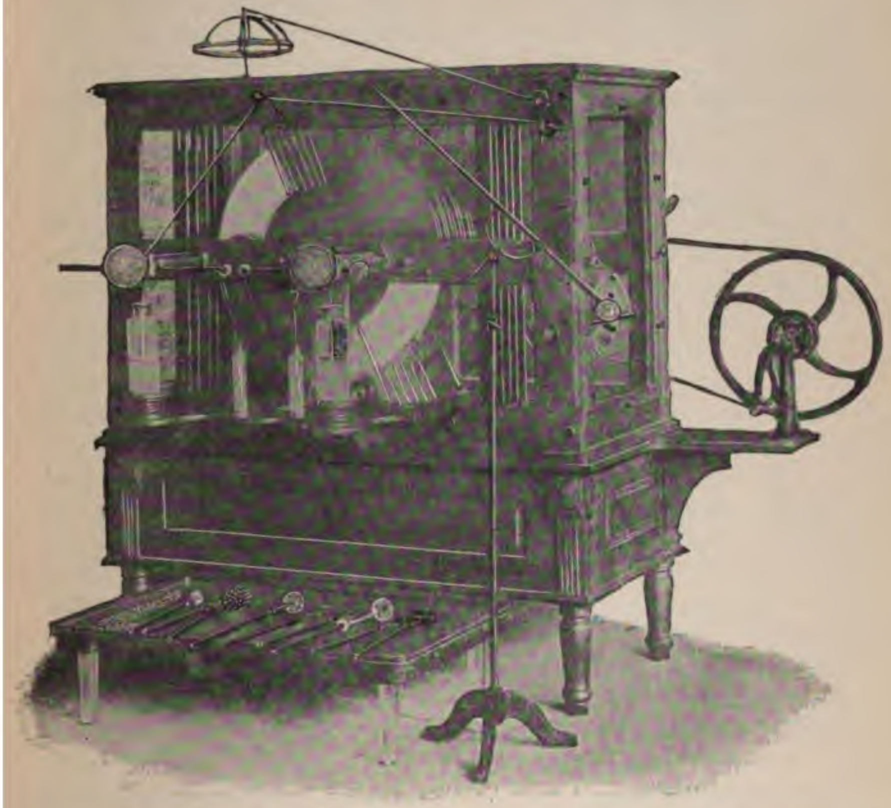


Fig. 129.—Type of Waite & Bartlett Machine. A Wimshurst charger is inclosed in the same case.

Secondly, it should be remembered that these generators of electricity consume nothing but the power required to turn them, the current being developed by the motion of parts composed of specially adapted materials separated by air-spaces, both materials and air being necessarily dry. It follows that too much skill cannot be expended in the purely mechanical parts of the machine to insure proper wear under the necessary motion, and that the electric parts should be adequately protected from moisture.

A well-made machine should also be kept in order to give good service. This means frequent oiling of the bearings, occasional airing of the case in good weather, and particularly the maintenance of a proper adjustment of the stationary plates and brushes in order that no unnecessary friction should occur.

Various means have been taken to maintain dryness within the case. The author recommends, from a long experience, that the anhydrous chloride of calcium[1] be kept constantly in the case, about four pounds being distributed in two or three granite-ware pans, which are taken out when signs of deliquescence appear and the water driven off by boiling dry over a gas stove. In very wet climates an additional precaution of value is the placing of two or three incandescent lamps in the upper part of the case to keep the machine warm, the lights being turned off when the machine is in use, as the filaments are then apt to be destroyed by induction if carrying a current.

An electric motor is, of course, the most convenient means of operating static machines, though a water-motor, gas-engine, or the office-boy will suffice, the last expedient being most unsatisfactory. With the former means it is essential that proper devices be supplied for regulating the speed, as the exigencies of various cases demand that the machine be driven at various speeds, from mere motion to high velocity. The tremor and unpleasant buzzing sound at times produced at high speed should be avoided if possible, as it is liable to be unpleasant to a sensitive patient.

"Ground" Connections.—In static applications profound modifications of the current may be obtained by including various static capacities in the circuit—either the floor and walls of the room connected with one pole, or, for greater condenser capacity, a convenient metallic mass, such as the gas pipes of the house. This is most readily done by attaching a bared wire permanently to the gas pipe and conducting it along the washboard to two binding posts attached to the washboard at either end of the machine to permit of "grounding" either pole at will. A farther modification of electrostatic capacity is obtained by having another mass of metal for the spark electrode to be attached to in giving indirect sparks, the opposite pole being grounded to the gas pipe as described. This second mass of metal may be the water pipes, as explained in the description of the attachments for this form of spark.

---

[1] In this recommendation the author differs from the conclusions of Dr. Grad, given in Chapter XXXI.

Precautionary Hints.—Leyden jars are practically never used in treatment, except the smallest ones when applying the static induced current; sparks drawn with them in circuit are too painful.

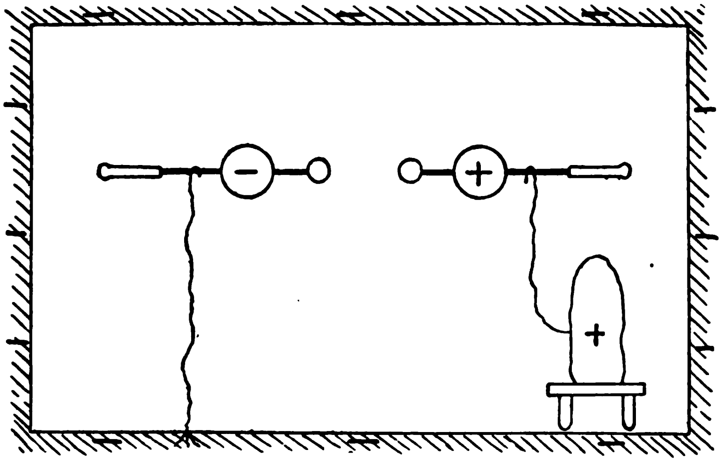


Fig. 130.—Static Charge. Patient, on insulated platform, holds chain connected with one pole. The opposite pole is grounded. The diagram shows positive insulation, all surrounding objects being negatively charged.

Lady patients should remove corsets, metallic hair pins, and metallic chains before treatment, as they give rise to irregular inductions and small sparks. *And, most particularly, all celluloid combs, hair pins, and other articles of this material should be removed,* as in at least two recorded instances these articles have been set on fire by strong spray currents, resulting in disastrous burns.

Do not start the machine until the patient and electrodes are in position, with the discharging rods *withdrawn widely* if a spray is to be given or *closed* if sparks or the wave current is to be administered, to avoid unpleasant shocks at the beginning of the application.

Methods of Application.—In all applications the patient sits or stands on an insulated platform (which should be elevated from the floor by solid glass legs), and the platform or projecting portions of clothing should not be closer than two feet from the machine case or other furniture, to prevent leakage.

Various forms of applications are employed by different workers in electro-therapeutics, the following being most frequently used:—

Static Charge.—The attachments for the positive charge are shown in Fig. 130. This is employed as a mild tonic.

Static Spray.—This is shown in Fig. 131. It may be greatly intensified by using a tinsel rosette instead of a crown piece, directed to the part of the body desired, if the part of the body be bared of clothing and covered with a folded, loosely woven, woolen "nubia" (an old-fashioned article of ladies' headwear). Strong revulsive effects, increasing to actual blisters, may be produced by this modification of the spray when the patient is connected directly with the positive pole. The author believes that this intensified spray, which is original with himself, has a deeply penetrating action, and is valuable in intractable chronic rheumatism.

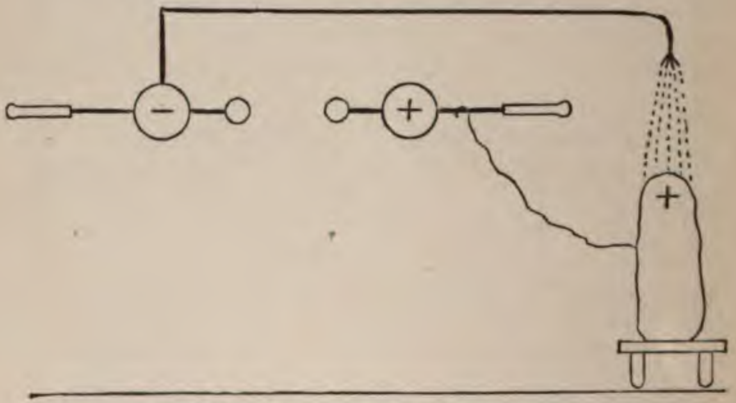


Fig. 131.—Connections for Positive Spray.

Indirect Sparks.—Fig. 132 shows the connections for the indirect sparks with one "ground" capacity. If the electrode chain is attached to the water pipe (the indifferent pole being attached to the gas pipes) more capacity is gained, and single sparks give good muscle responses with little pain.

Direct Sparks.—Direct sparks, shown in Fig. 133, are very painful, and rarely used except in anesthesias of the surface. They are much less painful, though still mainly a surface stimulant, when the current in the patient's circuit is lessened by allowing most of it to flow directly between the discharging poles, as shown in Fig. 134.

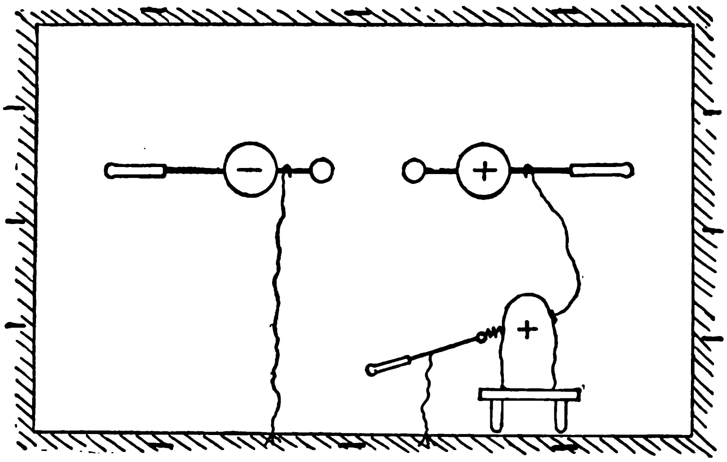


Fig. 132.—Indirect Sparks.

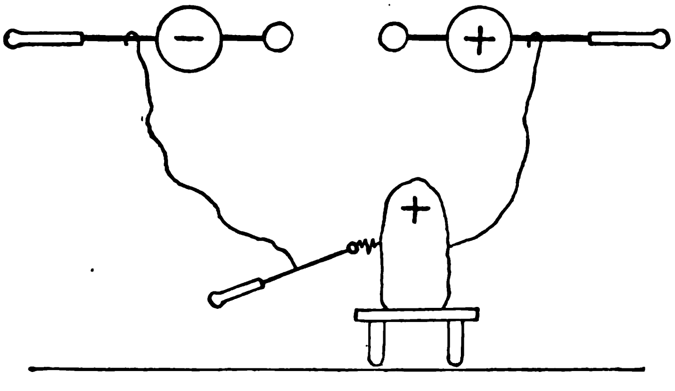


Fig. 133.—Direct Sparks.

Wave Current.—The wave current (Fig. 135) is obtained by grounding one pole and connecting the other to a thin metal plate applied directly to the skin of the part to be treated. The effect may

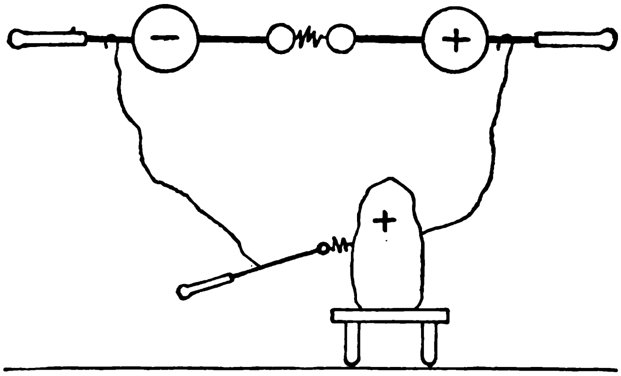


Fig. 134.—Direct Sparks with Patient in Shunt.

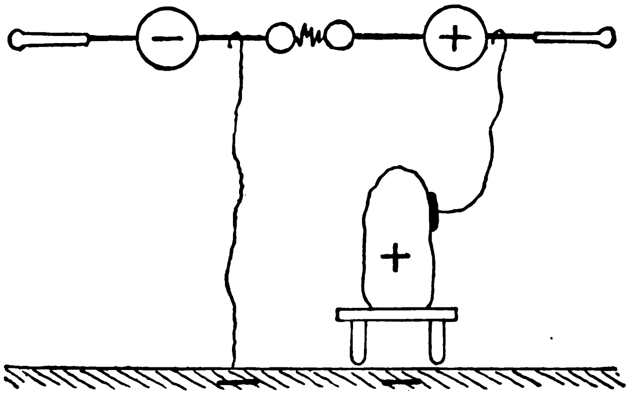


Fig. 135.—Morton's Wave Current.

be increased by carrying another wire, not shown in the figure, from the patient to a metallic capacity near at hand. This application should be begun with the discharging rods touching. After the machine is started they are gradually separated until the desired strength of charge is reached.

Static Induced Current.—The connections for this little used current are shown in Fig. 136.

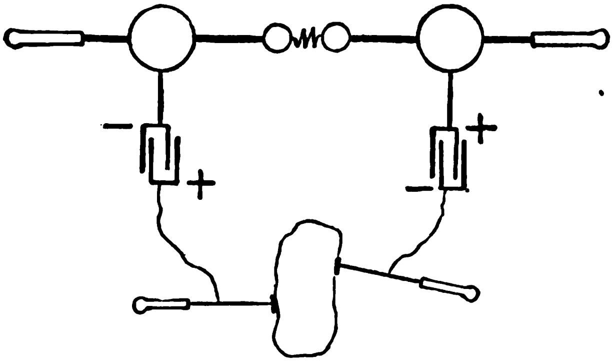


Fig. 136.—Morton's Static Induced Current.

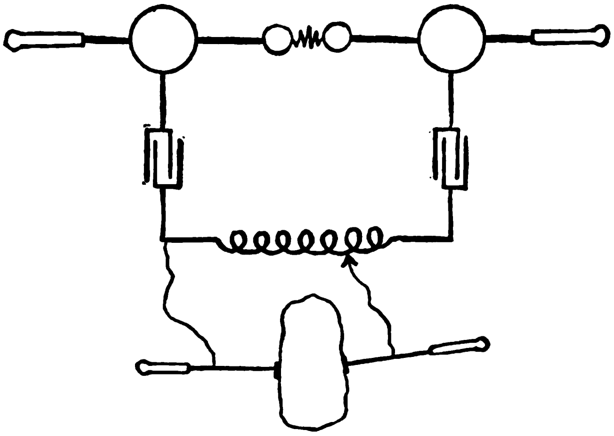


Fig. 137.—Diagram of Transformer Connections for High-Frequency Currents from Static Machine.

High Frequency and High Potential Currents, as obtained from a solenoid step-up transformer actuated by a static machine, are shown diagrammatically in Fig. 137.

Vacuum Tube Currents (Fig. 138) are readily obtained from the modern static machine without a transformer. The perfection of this machine in this country renders the use of coils for the last two modalities of doubtful necessity.

Ozone Administration.—The passage of these high-pressure currents through the air results in the production of considerable quantities of ozone from the aërial oxygen, and an apparatus has been devised for its administration; but, as ozone is admixed with nitrous acid, its value is problematic.

Polarity of Static Currents.—This is easily determined by starting the machine with the rods about two inches apart, and noting that the spark is *whitest* near the *positive* pole, due to incandescent oxygen being whiter than incandescent nitrogen.

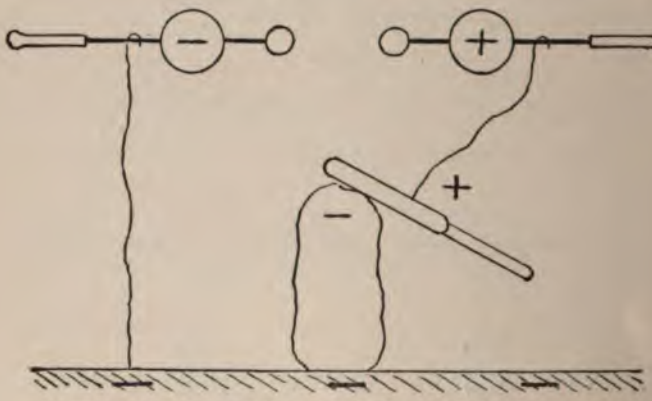


Fig. 138.—Connections for Vacuum Tube Currents.

After Using the Machine.—To maintain the charge all chains should be removed from the prime conductors immediately after use and the rods left separated.

Therapeutic Uses in Gynecology.—In adaptability to the needs of the gynecologist the static current depends for usefulness on his recognition of the neural relationships of many affections apparently arising in the sexual organs, as well as on the purely neural character of much of his work, for its value in chronic sciatica, insomnia, chronic rheumatism, and various neuroses is very great. An important fact first noted clearly by Apostoli is that the strong spark treatment enables us to discriminate between hysteria and neurasthenia. In hysteria the patient is capable of receiving a truly enormous voltage in the shape of sparks, with but little sign of feeling them. This is because hysteric analgesia is so common in these cases, and it may be noted that under the stronger sparks the hysteric cases improve until finally the sparks give as much pain as is normally produced in the healthy person. In neurasthenia no such

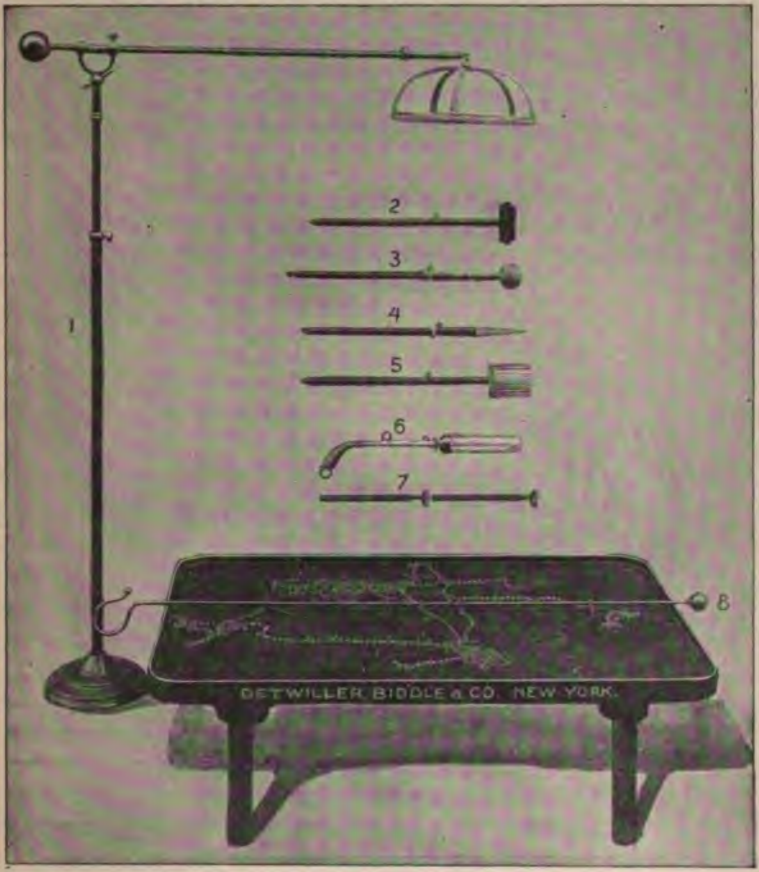


Fig. 139.—Some Electrodes and the Insulated Platform Used in Static Applications.

tolerance of the spark treatment is ever found, this form of application being usually so stimulating as to be wisely superseded by the spray. Among the cases favorably affected by this current those of neurotic backache stand pre-eminent, and, in fact, some form of static treatment may well be conjoined with pelvic applications of other currents if this symptom be prominent in connection with organic pelvic disease. For mere sedation the positive charge may be used. For neurasthenic conditions the negative spray, or the stronger positive spray, either stationary or mobile, followed later by the lightest, shortest sparks.[1]

When a patient is under other forms of treatment for hysteria or neurasthenia it is usually necessary to suspend applications during the menstrual periods. At these times the static spray or static charge may be substituted with advantage, maintaining the treatment without the harmful break that often interferes with quick results. That no disrobing is required for this application is a distinct advantage at this time. Menstrual discomfort is lessened, and no risk of causing an undue flow is encountered, as might be the case with the constant current.

The treatment of menorrhalgia of the neural type may be conducted, at times, entirely with the static currents, the positive spray being directed to the lumbar region, with the patient sitting sidewise on a chair placed on the platform and grasping a chain connected with the positive pole. The spray should be strong enough to produce distinct stinging sensations, and may be followed by light sparks to the same spot and to the hypogastric region. These applications are always helpful at and before the menstrual periods in nervous women, particularly if the nervous symptoms present at these times are attended by scanty flow.

For the treatment of the nervous disorders of the menopause, either natural or when artificially produced by ovariotomy, the static methods are often extremely useful, rendering the employment of neurotic and sedative medicines unnecessary. Both the head-spray and general sparks may be used.

---

[1] It should be noted that the expression "positive spray" means that the patient is connected with the positive pole, while the spray electrode is attached to the negative pole.

CHAPTER XXX.

THE SINUSOIDAL AND INCANDESCENT ALTERNATING CURRENTS.

The Sinusoidal Current.—For a number of years the author has been aware that the successful production of muscular stimulation with a minimum of pain was largely dependent on the smoothness and clearness of the note produced by a good interrupter of an induction apparatus; that "raggedness," or irregularity, of these very imperfect means of interrupting the inducing current produced induced currents that were of limited usefulness on account of the pain produced. While on a visit to Dr. J. H. Kellogg in the summer

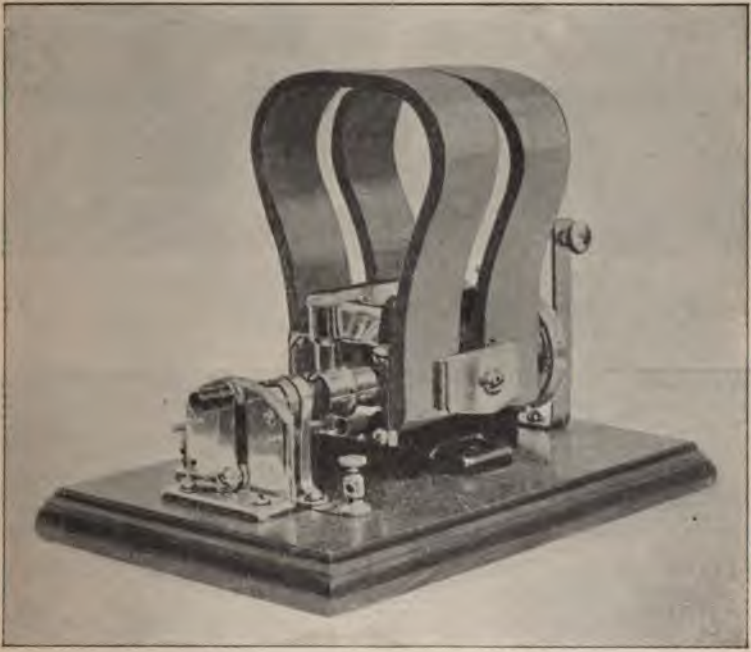


Fig. 140.—The Kellogg Sinusoidal Apparatus.

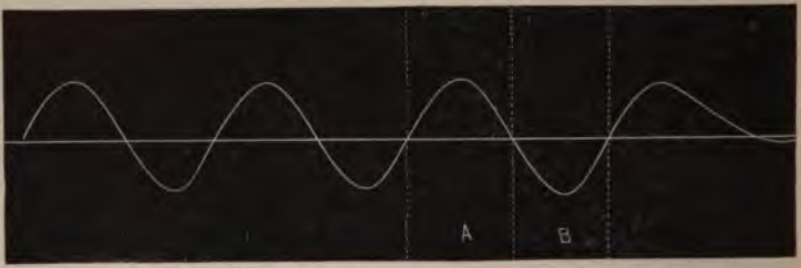


Fig. 141.—Graphic Representation of the Sinusoidal Current of Dr. Kellogg's Apparatus. *(Kellogg.)*

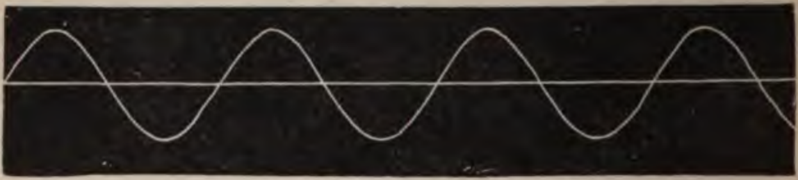


Fig. 142.—Sinusoidal Curve Obtained by d'Arsonval.

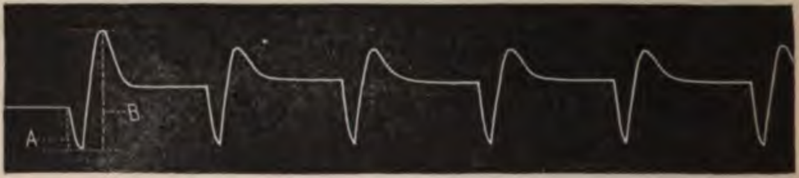


Fig. 143.—Current from Induction Apparatus (McIntosh). *A*, make; *B*, break. *(Kellogg.)*

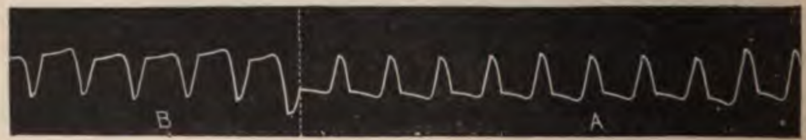


Fig. 144.—*A*, Current from Induction Apparatus (McIntosh), same as Fig. 143, but with Different Adjustment of the Rheotome; *B*, Current Reversed. *(Kellogg.)*

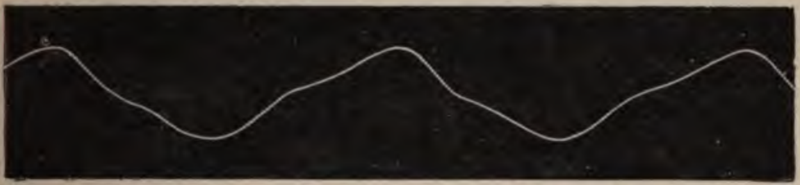


Fig. 145.—Representation of Magneto-electric Current not Sinusoidal in Character. *(Kellogg.)*

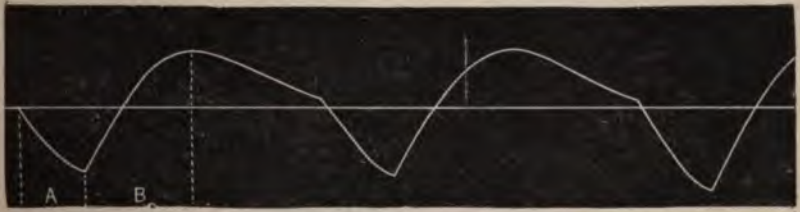


Fig. 146.—Current from du Bois-Reymond Coil. *A*, make; *B*, break. *(Kellogg.)*

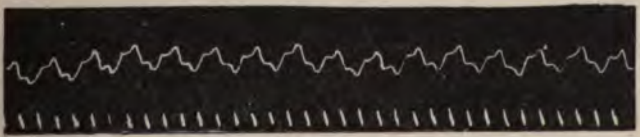


Fig. 147.—Characteristic Marking of the Rapidly Successive Inductions of a Poor Induction Coil. The time markings indicate $^1/_{280}$ second each. *(Kellogg.)*

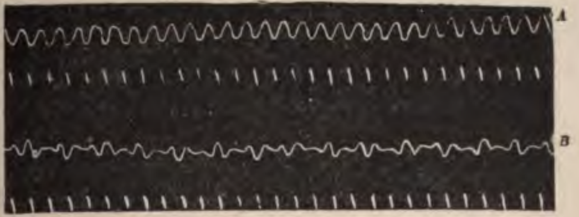


Fig. 148.—*A*, Current from Coil Excited by Thompson-Houston Arc Light, Alternating 16,800 Times per minute; *B*, Current from Secondary Coil of Ordinary Induction Apparatus Excited by Alternating Current. Time markings represent intervals of $^1/_{280}$ second. *(Kellogg.)*

of 1887 he was surprised to find a magneto-electric machine in use in his operating-room which produced vigorous contractions with but slight sensation (Fig. 140). The exact reason for this was not known until the researches of Professor d'Arsonval, of Paris, several years later, on the graphic delineation of the curves of induced currents, showed that a curve of smooth and uniform rise of potential produced painless contraction, while irregular rises and falls of potential were painful. By means of an electrograph the curves of current-variation may be readily recorded on a revolving cylinder, the accompanying figures (141 and 142) representing the curves thus obtained by d'Arsonval and from Dr. Kellogg's apparatus. The curves shown in Figs. 143 to 148 are in marked contrast to these, showing the ragged character of the irregular rises and falls of potential, and explaining the pain-producing character of all induction currents of any considerable volume.

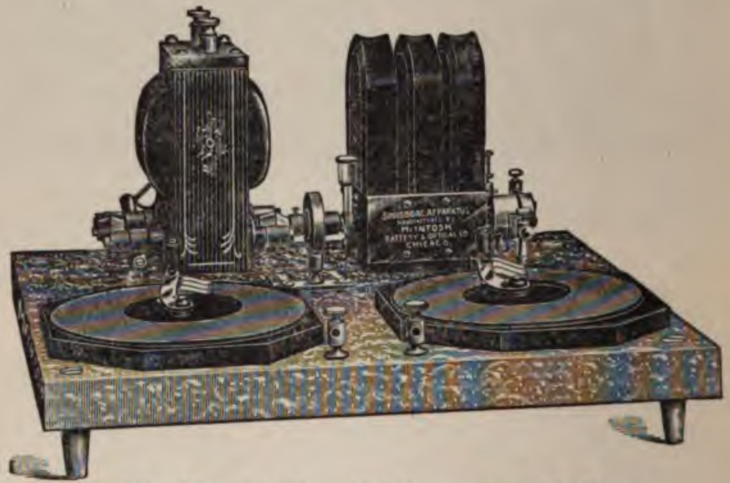


Fig. 149.—McIntosh Sinusoidal Apparatus, with Motor.

The sinusoidal current has a smooth and gradual variation, consisting of both an equal rise of potential above and fall below the zero-line. This latter curve of variation represents the highest and most painless efficiency in muscle-stimulation with slight ampèrage, the contraction being proportional, of course, to the three elements of volts of rise, suddenness of rise, and milliampèrage of current.

It is thus seen that the sinusoidal current is typically adapted for muscular stimulation, for by properly constructed apparatus we may apply a far greater milliampèrage for this purpose than the pain-producing qualities of the primary induction current will permit. The exact milliampèrage of these currents is yet undetermined, but depends on the current circulating around the field-magnets of the alternator. That it is usually intermediate between the constant and induction currents is shown by the fact that they will readily stimulate the special senses of sight and taste.

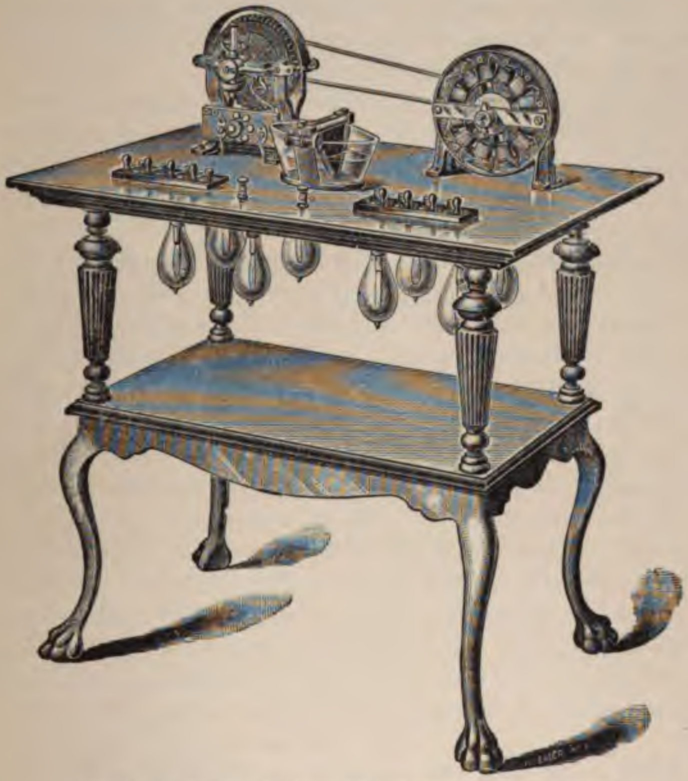


Fig. 150.—Kennelly Sinusoidal Apparatus and Motor.

The ease with which a large number of complete alternations per second of this smooth character can be obtained renders the sinusoidal current an excellent nerve-sedative.

Sinusoidal currents are produced by little alternating current dynamos, with either permanent magnets or electro-magnets, which are operated by any convenient source of power, an electric motor being the best. The patient is placed in a shunt circuit with a Massey controller, which is operated in a reverse manner,—that is, the lever is placed all the way around on the graphite area at the start, when all the current goes through the instrument instead of the patient; by turning the current off the controller gradually it will increase through the patient's circuit with equal step.

The only drawback to this instrument as compared with the induction apparatus is its bulkiness and the fact that from two to four large acid-carbon motor cells must be used to operate it and the motor, or four times as many Edison-Laland cells, in the absence of the more convenient street current.

The Incandescent Alternating Current.—This current, which is very largely used at present as an illuminant of houses and offices, is obtained from step-down transformers placed on the exterior of the house, by means of which the high voltage of the street mains is reduced to either 52 or 104 volts, according to the transformer used and the lamps supplied. It may be employed in medical applications in place of the induction, but, not being truly sinusoidal in character, is generally painful even when greatly reduced. The author's current-controller forms an efficient means for its control, when protected by a small fuse, the instrument being simply intercalated between the wires from a lamp-socket and the patient. As already said, this current is distinctly alternating in character and incapable of lasting electrolysis or cataphoresis. It can, in no sense, be employed as a constant current, therefore, in spite of the similar heat- and light-producing effects in the large ampèrage traversing the filament of the lamp.

There is, at least, one emergency in which its modern ubiquity may make it of service in saving life,—namely, in postpartum hemorrhage in a house supplied with this current and where a battery is not to be had. The cord of a drop-light could be unwound and one wire applied by coiling it in a wet pad to be placed on the back, while the other is dipped in a dish of water; a third wire from the opposite side of the dish of water going to a pad on the abdomen. When the wires in the water are brought closer or when a little table-salt is dropped into it, a means of gradually increasing the current to the point of tolerance is thus readily produced, with powerful contracting effects on the relaxed uterus.

Transformation of Alternating Current into a Direct Current.—An alternating current may be transformed into a direct current of 110 volts for medical use, and rotary transformers for this purpose are sold by some manufacturers. Unless the physician employs electricity constantly such an arrangement is expensive and troublesome, dry cells answering every purpose.

CHAPTER XXXI.

ROENTGEN RAYS IN DIAGNOSIS AND THERAPEUTICS.

BY HERMAN GRAD, M.D.,

NEW YORK CITY.

INTRODUCTORY.

IT may safely be said that skiagraphy has passed the experimental stage, and as an art has attained the dignity of being a positive means of diagnosis in fractures, dislocations, and foreign bodies. Heretofore, of all the symptoms that arose incident to the solution of the continuity of bone, crepitus held the foremost rank. Upon this symptom a positive diagnosis of fracture was made. This symptom, however, can be elicited only under exceptional circumstances. In many cases no crepitus can be obtained, and yet solution of the continuity of bone of a very serious nature may exist. Nor is it of small significance that the elicitation of the symptom causes distress and suffering; and when crepitus cannot be obtained, only a doubtful diagnosis of fracture is admissible. Hence arises the fact that without a skiagraph a positive diagnosis in every fracture cannot be made. Furthermore, even if the diagnosis of fracture is positive in a given case, the skiagraph will give much additional information, obtainable in no other way. A skiagraph shows with startling vividness the extent of the bone injury, the position of the fragments, the rotation, the overriding, and the shortening and displacement—information of the utmost importance in the diagnosis and treatment of the injury. Therefore no diagnosis of a fracture is complete—and certainly not scientifically so—without a skiagraph of the injury. With an x-ray plate of the injury of the bone at our hand the diagnosis and treatment of the fracture become an open book. That fractures and dislocations can be diagnosed and treated intelligently and successfully without the aid of an x-ray picture is freely admitted, but that the diagnosis and treatment of these very fractures, so handled, become less problematic with a skiagraph at hand must also be freely conceded. The value of skiagraphy in fractures, dislocations, and foreign bodies being admitted, the most practical way of obtaining an x-ray picture becomes a matter of importance.

The practical application of the Roentgen rays in fractures, dislocations, and foreign bodies requires the intelligent use of certain apparatus. With efficient apparatus at hand the technique of successful skiagraphy becomes very simple. We need for the purpose either a static machine or an induction coil, a Crookes tube, a stand, a fluoroscope, photographic dry plates, trays, and a ruby lamp. With these seven kinds of apparatus we can go to work and diagnose conditions where the x-rays have so successfully been applied. It need hardly be recalled to what importance in diagnosis the x-ray has attained. A short description of each piece of apparatus used in producing a radiograph is necessary.

Static Machine.—To do efficient work in radiography with a static machine of glass plates it is necessary that the machine should have at least ten revolving plates. While a radiograph can be obtained with a six-plate machine, these small machines are not practicable. With a twelve-plate static machine very good x-ray pictures can be made. The time of exposure is not very long, and, on the whole, if the operator has only this piece of apparatus in the office he will be able to radiograph every skeletal bone in the body except the head and hips. For the latter regions of the body the time of exposure with the static machine becomes too lengthy. The risk of a dermatitis in such a long exposure is very great. However, even the hips and head can be radiographed if the subject is not too fleshy. Young subjects admit easy penetration of the x-rays.

It is not our object here to describe the entire construction of a static electric machine, but to dwell upon a few points in its make-up may not be amiss. A static machine, while not a very delicately constituted piece of apparatus, requires some care and attention on the part of the operator. A machine that is well constructed and has good insulations on the metal parts should do good work, if the machine is properly cared for. It is necessary to keep the machine in a dry room where a certain amount of sunshine enters. The exposed brass parts should be kept free from dust and the axle properly oiled. All static machines, no matter what their construction, require some means whereby the interior is kept dry. I have discarded entirely the use of calcium chloride for this purpose and use instead the unslacked lime. Lime will not alone keep the interior of the machine dry, prevent it from becoming discharged, but will do away with all of the unpleasant odors that we find when the case of a static machine is opened. A machine with lime in it can be opened at any time and only a very slight odor of nitrous oxide gas will be encountered. Nor do the metal parts of the machine tarnish so readily as is the case when calcium chloride is used to dry the machine. The lime should be about fifty pounds in weight, in large bricks (unslacked). After a time the lime slacks in the machine, and in doing so it becomes a powder. When the lime is in

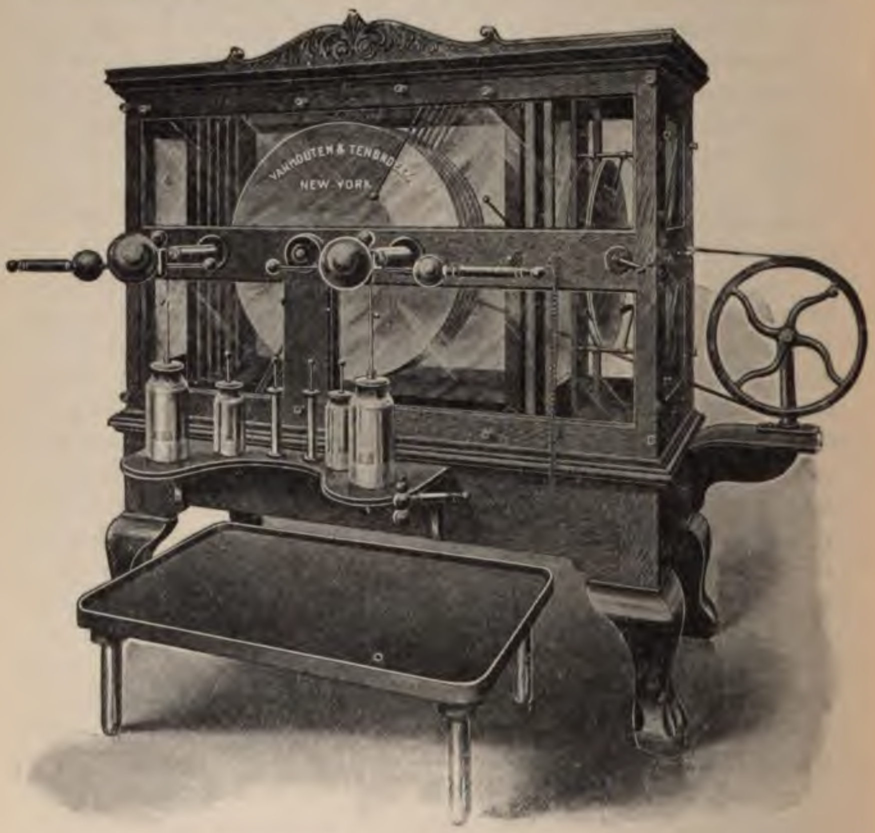


Fig. 151.—Van Houten & Ten Broeck Static Machine.

powder it is of no further use for such purpose. This powder must not be allowed to fly about in the case and settle on the plates. The bricks of unslacked lime should be put in a box made of slats and covered with gauze or linen to prevent the powder from flying off. Every six or eight weeks the lime is changed and a new supply put in. In order that the machine should keep the charge it is necessary to have it run every day. If not in use, allowing the machine to run from five to ten minutes morning and evening with the sliding rods fully apart will prevent the machine from discharging. With these little attentions the static machine can be made very serviceable and kept in readiness for use at any moment. When the weather is dry the machine should be aired for a few minutes each day. Start the machine off fully charged, and while running take off the most convenient side door and allow the air to enter for three or four minutes. This airing will materially improve the capacity of the machine. Under no condition, however, should the interior of the machine be aired in wet weather or during hot summer days when the humidity is great. A good motor to run the machine is a prime requisite in the use of a static machine, and nothing can equal a good electric motor. While any motive power will do the work, yet nothing is so handy for a physician as an electric motor. Gas and gasoline engines require much attention, and so does a water motor. Of course, if electricity is not available a gas engine will probably be the least troublesome motive power. To run a static machine successfully by hand is out of the question. With these few precautions a thoroughly constructed static machine will do good work.

Induction Coil.—An induction coil for this purpose is an apparatus for the transformation of an electric current of low voltage and high amperage to one of low amperage and high voltage. In order to excite an x-ray tube it is necessary to have a current of electricity of very high tension and low amperage. In a static machine we have just such a current. The current there is of tremendous voltage, but exceedingly low amperage. In obedience to certain definite electric laws, the induction coil converts the ordinary commercial current used for power and lighting purposes into a current of high tension or "voltage." This transformation occurs under the following conditions: If we take a coil of wire attached to a galvanometer, we will notice that a momentary current will be induced in the coil when a magnet is brought near it, although the magnet does not touch the wire. When the magnet is removed another momentary current is produced; but this time the electricity flows in an opposite direction. It is on this law of induction in electricity that the construction of an induction coil is based. An induction coil consists of a so-called primary core and a secondary winding. The primary core represents the magnet and the secondary winding the coil of wire previously mentioned. When electricity is allowed to flow into the primary core it becomes a magnet. The instant the circuit is opened, a current of electricity develops in the secondary winding by induction, the current flowing in a certain direction. This phenomena of induction repeats itself when the current flowing through the primary is stopped, or, technically speaking, the circuit is "closed." This opening and closing of the flow of electricity in the primary of an induction coil is called the "making" and "breaking" of the current. The current developed in the secondary winding of an induction coil is what is utilized in the production of the Roentgen rays, for the Roentgen rays can only be produced by an electric current of

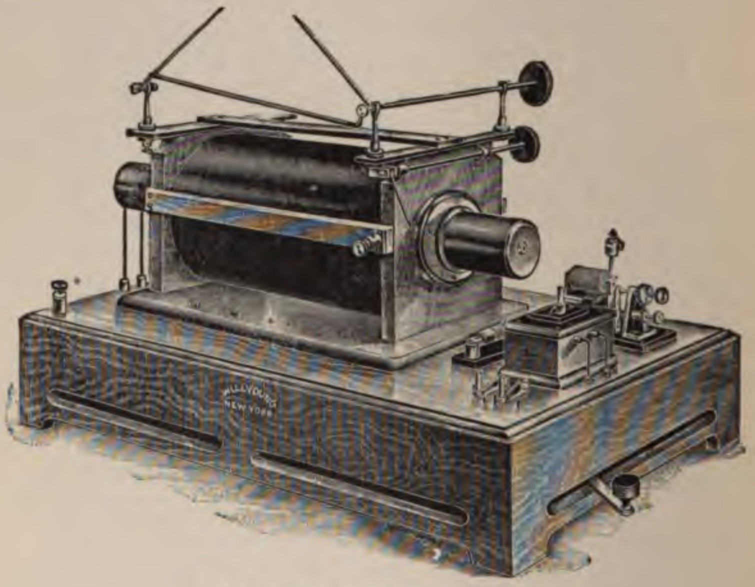


Fig. 152.—Roentgen Ray Coil.

high potential and low amperage. As this particular kind of current only develops in the secondary winding of an induction coil, at the instant of the "make and break" of the current flowing through the primary core, it is essential to provide for the "making" and "breaking" of the current. This is provided for by that portion of the induction coil outfit called the interrupter.

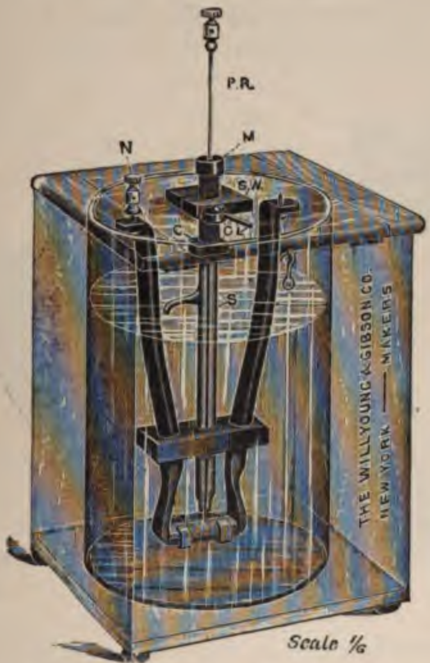


Fig. 153.—Electrolytic Interrupter.

Interrupter.—There have been many devices advanced for "making" and "breaking" of the current that enters the primary coil, but the most successful of these devices is the electrolytic interrupter of Wehnelt or some modification of the same. The interrupter consists of a glass jar in which is suspended a plate of carbon of a definite device. A platinum wire, also of a definite device, is so suspended that it keeps a certain distance from the carbon plate. This distance can be varied by means of a screw. The glass is filled with a sulphuric acid solution—enough in quantity to immerse the carbon plate and the platinum wire. The electricity that is allowed to flow into the interrupter decomposes the water, and the liberated gases around the platinum point break the circuit, thus interrupting the current, the non-conducting material being the liberated gases. These gases, being lighter than water, rise to the surface and unite again to form water. The gases having left the platinum point, the circuit is again closed, the electricity once more flows, and the phenomenon repeats itself indefinitely, the interruptions occurring with great rapidity, several thousand times per minute. The interrupter is a very important part of the x-ray outfit, and no time and labor should be spared in making it as perfect an instrument as possible. The platinum point in an interrupter after a while will wear out, and must be replaced.

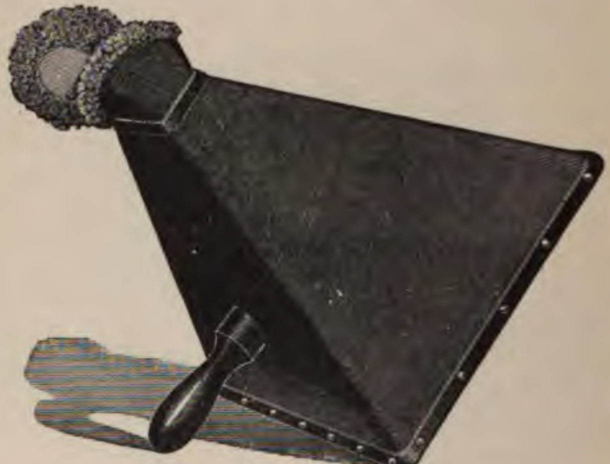


Fig. 154.—Fluoroscope.

Fluoroscope.—The fluoroscope is a convenient device for holding the substances which fluoresce when they are brought into the vicinity of a Crookes tube in action. It is a box of stereopticon shape, the opening at one end being just large enough to fit over both eyes of the observer, and made to exclude all outside light. The best fluorescent material for practical purposes is the platinocyanide of barium. These crystals are spread over a cardboard in a very thin layer, which is fastened to the large end of the fluoroscope. The fluoroscope then becomes a dark box, and when in use should not admit any extraneous light. When the fluoroscope is brought into the vicinity of an active x-ray tube fluorescence is excited in the crystals of the platinocyanide of barium, and objects, opaque to x-rays, when placed between the screen and tube, throw a shadow on the fluoroscopic screen. These shadows are what we see. We do not see the so-called x-rays, but the shadows on the fluoroscopic screen. When the hand is placed in front of the screen the bones become visible because the x-rays do not penetrate the osseous structures as readily as the soft tissues, and, hence, the crystals of the fluorescent substance at these regions receiving less x-rays, they fluoresce to a slighter degree, and this difference of fluorescence of the crystals produces the effect of a shadow. It is this shadow that we see. We do not see the bone actually, but the shadow of the bone. It is of importance to bear this in mind, because seeing only a shadow means that we only see a surface of an object in a single plane, and if we wish to get an idea of the entire object we shall have to look at the object from different angles, so as to see the shadows of the different planes. The fluoroscope is of great practical utility in surgery and medicine. Foreign bodies in the various cavities of the body, as well as in the tissues, and bullets in any part of the human body can be seen and located with the fluoroscope. In fractures and dislocations, as well as bone diseases, the fluoroscope will afford much information, but not as much as the photographic plate. In diseases of the chest, however, the fluoroscope finds great usefulness, because the various organs here can be seen in their natural position and motion. It certainly cannot be of trifling interest to be able to see a heart in action; the rhythmic contraction of the diaphragm; the up and down motion of the liver, spleen, and kidneys; the shadow of the mediastinum, etc.

Radiographic Plate.—In radiography the ordinary photographic plate is used, although manufacturers are putting up special plates for x-ray work. These x-ray plates differ very little from photographic plates. With ordinary plates used in a camera very good x-ray negatives can be obtained. A photographic plate is a piece of glass coated with a solution of silver bromide and gelatin. When a solution of silver bromide is exposed to sun or artificial light, the solution becomes decomposed into the subbromide of silver. Expressed chemically, the $AgBr$ is changed to Ag_2Br. The same chemic change occurs on the gelatin-coated plate. A plate on which these chemic changes have taken place does not show anything visible, but when the plate is subjected to another chemic called "a developer" the subbromide is converted into metallic silver. At this stage the plate is immersed in a "fixing bath," which dissolves off the silver bromide that was unaffected by the light. It thus fixes the plate and makes it permanent. The plate, or "negative," as it is now called, is of a brown or black color, whereas before the development the plate looked white. As the bromide on the plate is so sensitive to all kinds of light, except the ruby light, it stands to reason that it must be protected from light during development and fixing, and all manipulations must be done either in the dark or by a ruby light. In photography the plate is exposed in the camera, but in radiography no camera is necessary, because the x-ray light that is to bring about the chemic changes on the plate can penetrate dark paper, for example, which is impervious to ordinary light. Photographic plates come in various sizes, but the most convenient sizes for radiography are the following: 5 by 7, 8 by 10, 10 by 12, 11 by 14, and, on rare occasions, 14 by 17. In ordinary plates for x-ray work the envelopes should not be forgotten, as the envelopes take the place of the dark plate-holder of the camera. It is of importance to remember that the x-ray plates should not be kept in the same room where x-ray work is being done, as the plates would necessarily become fogged. It is best to keep the sensitive plates in a tin box, which is more or less impervious to the x-rays. When the plates are to be used they should be taken into the dark room and put into the envelopes in such a way that the film side of the plate should be next to the smooth side of the envelope. In this way one always knows where to find the film side of the plate. While it is not absolutely necessary to have the film side of the plate toward the part to be radiographed, yet we will get a better picture if this precaution is taken. In removing the plates from their original box to be placed in the envelopes great care should be exercised not to expose them to light. The whole procedure can be accomplished in a dark closet without the use of any light, although it is perfectly safe to expose them to the ruby lamplight. The film side of the plate should not be handled with the fingers, as the moisture and heat of the hand will affect the film unfavorably, and when the plate is developed it will show spots from careless handling of the film. While certain manufacturers are putting up x-ray plates which are ready for use, it is better for the operator to attend to these details himself, because in this manner

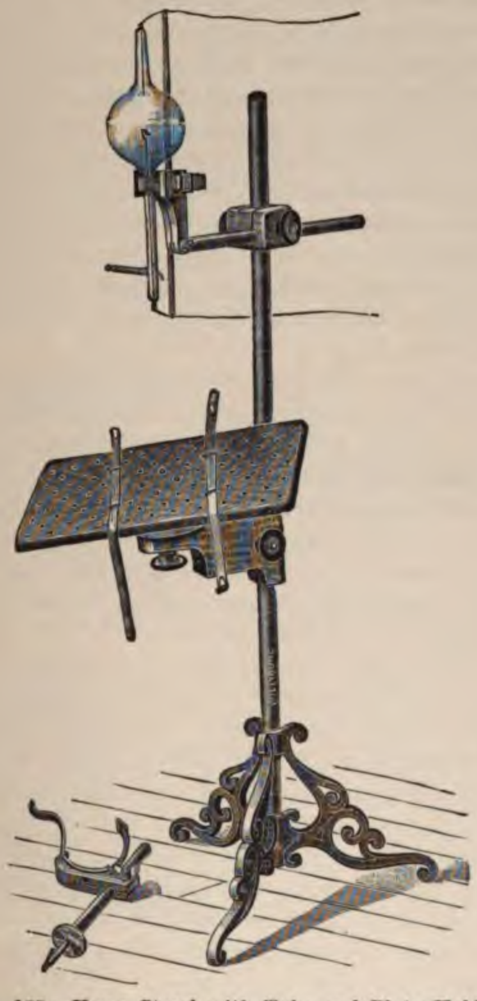


Fig. 155.—X-ray Stand with Tube and Plate Holder.

only can he have control of those fine details of the work so essential to successful radiography.

Stand.—A stand is an arrangement for holding the x-ray tube while in action. As it is necessary to place the tube in various positions at different times, it is essential that the stand shall admit variations in its handle to accommodate the tube. There are now on the market many very excellent stands. A good stand must be stable; it should have a handle of wood or some other nonconducting material; it should admit various positions, and have some simple device for obtaining these various positions. Too complicated a device is tiresome and impracticable. The simplest device is the best. It should also have some arrangement for holding up the attaching cords, as they are necessarily heavy if properly insulated. The base of the stand should be heavy so as to be stable. When tube and plate are once placed in position there should be no further motion of the tube, as the focus would be disturbed. Therefore the various screws on the stand should be well set.

Trays.—The trays are used for the developing solutions. For each set two trays are necessary. One is for the "developer" and the other is for the "hypo" solution, also called "fixing" solution. The various sizes of the trays should correspond to the sizes of the plates. The three most convenient sizes for practical radiography are 5 by 7, 8 by 10, and 10 by 12. Hard-rubber trays will serve the purpose well. It is best to keep one tray for the same solution. The "fixing" solution should always have the same tray. When the trays are not in use they should be kept clean and dry.

Lamp.—As the photographic plate is sensitive to all kinds of light except the "red" light, it is necessary to work only with red light during the development of the plates. For this purpose an oil lamp is provided, the sides of which consist of red glass. These ruby lamps, so called, are made in various sizes, but the smaller sizes are not practicable. For x-ray work a fairly bright light is permissible. The x-ray plate is not apt to fog so readily as an ordinarily exposed plate. Electric lamps with red bulbs are very practicable devices for obtaining red light, but ordinary incandescent lamp bulbs are apt to be too light. However, with a little ingenuity these electric bulbs can be toned down to the desired brilliancy.

Tube.—An x-ray, or Crookes, tube is a glass bulb, globular in shape, the air in which has been exhausted. It is a vacuum tube, the pressure in the tube having been reduced to one one-millionth of an atmospheric pressure, or thereabouts. The manufacturer finds it very difficult to gauge the intratubal pressure, hence results the great variability of the vacuum of the tube. Then, again, one tube may be exhausted to the same extent as the next one, and yet these two tubes will behave differently when they are used for some time. The rarefied air in the tube becomes radiant when electricity is allowed to flow into this relative vacuum. In fact, this phenomenon of fluorescence of a vacuum tube led up to the final discovery of the so-called x-rays, by Wilhelm Conrad Roentgen in 1895. To obtain a good x-ray tube, with proper vacuum, is no easy matter. The manufacturer may follow identical steps in the preparation of his tubes, and yet some of the tubes will turn out well, while others will not. It is the degree of proper vacuum that is difficult to obtain. The reason for the great variability of the vacuum in various tubes is not understood fully. Then, again, a tube may be of a proper vacuum at one time, and the next time it is to be used the vacuum will have risen so high that the most powerful coil will not be able to light it up. A tube whose vacuum has become high will become reduced if allowed to rest for a variable period of time. These are interesting phenomena about x-ray tubes, but they add to the difficulties and the problems of radiography. It means that before each exposure the tube has to be tested and its vacuum adjusted if success is to be attained.

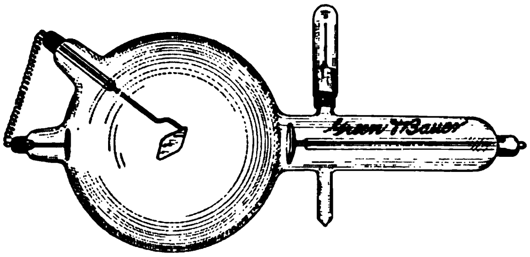


Fig. 156.—Roentgen Ray Tube with Light Anode, for Static Machine.

Into the glass bulb of a Crookes tube are fused two electrodes—usually one at each end. One electrode is called the *cathode* and the other the *anode*. The cathode is made of aluminum and its inner end is made into the shape of a cup. The purpose of this concavity in the cathode is to bring to a focus the cathode rays emanating from it, it having been discovered that the cathode rays obey the laws of reflection. The anode is made of platinum, as other metals would easily melt under the tremendous heat to which this part of the tube is subjected during the time the tube is in action. The heat evolved at this point in the tube is so great that even small pieces of platinum melt under it as easily as lead. It is therefore necessary that the anode should contain a considerable quantity of platinum. In tubes intended for the static machine alone a very thin anode will answer the purpose; but in tubes that are to be excited by a coil the anode should be extra heavy, particularly if the coil is one of considerable electric capacity.

In a Crookes tube that has been properly standardized as to the vacuum a certain quantity of electric energy will be necessary for excitation. After a while the tube will require more and more electric voltage to produce a proper degree of radiance. While in the one case the tube will back up a 3-inch spark gap, in another case it may back up an 8-inch spark gap. By "backing up a spark gap" is meant that the resistance to the flow of electricity in the tube is greater than the resistance of 3 inches or 8 inches of air. Air, as is well known, offers considerable resistance to the flow of electricity. Now, 3 inches of air-space between the negative and postive electrodes of an electric circuit will offer a certain amount of resistance. If the resistance in the tube is less than that of 3 inches of air, the electric current, always taking the shortest route, will necessarily flow through the tube, but as the resistance in the tube rises and becomes greater than that of the air the circuit will be through the air. An x-ray tube in action that backs up a spark gap of 3 inches is spoken of as a "low" tube. When the tube begins to back up 5 or 6 inches of spark gap it is spoken of as a "high" tube. In the first instance the vacuum is low; in the last it is high. In an x-ray tube it is necessary to have a certain amount of matter remain in the tube, as a perfect vacuum would defeat the object in view. The quantity of matter that remains in the tube after exhaustion determines the degree of vacuum of that particular tube. This quantity of matter, however, changes with each use of the tube, and, the more the anode of the tube is heated, the greater the resulting change in the vacuum of the tube. After much use the vacuum of a tube becomes so high that no amount of current can excite the tube, as the resistance in the tube becomes too great. The current does not enter, but sparks across on the outside of the tube.

In view of the fact that the vacuum in the tube is so variable, it becomes necessary to have some practical provision made whereby this vacuum can be regulated at will. It has been found that by introducing matter into a tube in a vapor form the vacuum can be regulated at will. This is accomplished in two ways. During the manufacture of the x-ray tube a separate compartment is provided for, which communicates with the large bulb of the tube; in this compartment are fused a small anode and a cathode. On the cathode a plate of selenite is placed, or else some potassium hydrate of phosphorus. When the vacuum in the tube proper becomes too high, a current of electricity is allowed to pass through the auxiliary tube for one or two seconds only; the potassium hydrate, or any other substance that may have been introduced into the auxiliary tube, becomes vaporized and the vapor passes into the main bulb of the x-ray tube, thus lowering its vacuum. Gundelach utilized the principle of osmosis in the lowering of the vacuum in the tube. He fuses a wire of palladium into the tube, the wire projecting outside of the glass. When the projecting wire is heated with an alcohol lamp, the hydrogen of the flame diffuses into the tube, or perhaps air is forced through the heated matter, thus lowering the vacuum of the tube. Still another method of lowering the vacuum of the tube consists in subjecting the tube to heat. The heating of the tube displaces the air resting against the sides of the tube, thus raising the pressure in the tube. Tubes excited by the induction coil, however, must be lowered by more energetic means than heating. Matter in a gaseous state must be introduced to lower the tube sufficiently.

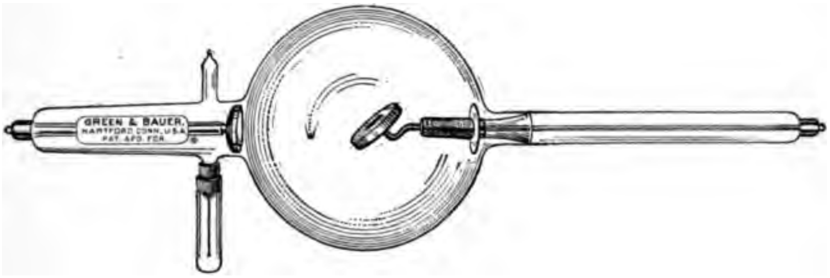


Fig. 157.—Roentgen Ray Tube with Heavy Platinum Anode, for Coils.

To prevent the overheating of the platinum on the anode, various devices have come into use to cool this part of the tube. The most successful of these devices are the so-called "water cooling tubes." Water is made to circulate about the anode to abstract the heat from it. In this way the anode may withstand a very powerful current for a few minutes' time. Under ordinary conditions an anode excited by a powerful induction coil will become red hot in a minute or two, rarely requiring three minutes. With a water-cooling arrangement the excessive heating of the anode may be delayed a minute or two. When it is considered, however, that it is really unnecessary to have an x-ray tube in action for more than one or two minutes at a time, it will be seen that tubes which will stand so much stress are rarely necessary. In radiography it is seldom necessary to have an exposure of more than two minutes at a time, even for stout persons. A hip can be taken in two minutes' time if the apparatus and tube are in good order. With an apparatus not so efficient longer exposure will be necessary, but under these conditions the tube can be allowed to cool for a few minutes, the patient in the meantime remaining quiet. When the tube has cooled off, the current can be turned on again and the exposure completed.

In referring to the vacuum, tubes are spoken of as being "hard" or "soft." These terms are not so well chosen as "high" and "low," because it is the degree of vacuum that is being referred to. Nevertheless, when the vacuum in a tube becomes high it is said that the tube has become "hard." When a tube has become high it is in some danger of being punctured. A punctured tube at once ceases to functionate, and, instead of the usual radiance seen in a well-working tube, a violet light appears between the cathode and anode; and if the puncture is a large one, even a spark will be seen in the tube. Such a tube can be repaired by sealing up the puncture in the glass and re-exhausting the tube. Tubes thus repaired may never again become as useful as they were before, although it is frequently the case that a repaired tube will turn out better than when it was new.

In measuring the degree of vacuum of a tube we have recourse to the spark gap that the tube backs up, the intensity of the radiance in the tube, the noise of the interrupter, and the general harmony in the working of the apparatus. These all inform the operator that everything is working well. Recourse, however, must be had, even by the expert, to the fluoroscope in finding out the degree of vacuum of that particular tube, at that particular time. The hand is a good skiameter after all. In the hand there are bones of various densities, and by examining these various regions of the hand the degree of the vacuum of the tube can soon be learned. This procedure, while eminently practical, and certainly very efficient, is not without considerable danger to the operator. An x-ray hand is apt to be the reward of the too zealous inquirer. If one does much x-ray work this method of estimating the vacuum of the tube should not be chosen, as dermatitis of a more or less serious nature is sure to follow. Under these conditions, a skiameter is to be substituted for the hand, and, the sooner the operator learns the use of the instrument, the better for his hands. There are a number of skiameters on the market. They are all based upon the same principle: that of interposing between the tube and fluoroscope some material which obstructs the rays. Small squares of tinfoil, or other suitable materials, are arranged in a circle. All the squares are numbered. By looking at the skiameter with the fluoroscope one can express the particular degree of the vacuum of the tube by the number on the square that appears opaque to the light of that particular tube. An ingenious device for measuring the degree of vacuum was devised by Dr. Carl Beck, which he calls an osteoscope. Instead of using the living hand the doctor uses the hand and forearm of a skeleton. He says: "The bones of the forearm and hand are fastened to a sheet of pasteboard, or similar translucent material. By being inserted in the frame of a fluorescent screen, it can be moved to and fro, so that the phalanges, the carpus, or elbow can be studied." He says further: "If a tube shows the bones of the osteoscope light gray and translucent, it is of excessive hardness; the contrast is insignificant, and therefore useless for Roentgen examination."

Nature of the Roentgen Ray.—When an x-ray tube is in action certain phenomena are observed. If a low tube is the subject of observation, a stream of violet light is seen passing from the cathode to the anode. These rays have been termed cathode rays. The cathode rays are supposed to consist of particles of matter in the tube, and, as these particles of matter are in a state of extreme attenuation, they have plenty of room to move about, and travel with great velocity. As the tube gets higher, the particles of matter have still more room to move about, and another phenomenon is observable. That part of the glass bulb of the tube which is in front of the anode begins to glow, and a radiance fills the bulb of the tube. These phenomena have been known to the scientific world for many, many years, but it remained for Roentgen to discover that something is coming away from such a tube which is capable of causing fluorescence in other substances outside of the tube. Not alone does the glass of which the bulb is made fluoresce, but substances like platinocyanide of barium, spread on a piece of cardboard, also fluoresce when brought into the vicinity of the tube, the phenomena of fluorescence extending three or four feet away from the tube. Furthermore, the fluorescence goes on whether the cardboard side is turned toward the tube or that side upon which is spread the fluorescent substance. It is evident, therefore, that the energy or matter that comes away from the Crookes tube is capable of penetrating cardboard. Again, if the tube is covered entirely with black paper, which is impervious to sun or artificial light, it will not interfere with the fluorescence of platinocyanide of barium. Believing that this something is a form of ray, Roentgen called it an x-ray. That this ray is not the cathode ray has been proven experimentally. Cathode rays are deflected by a magnet, but the x-rays cannot be deflected by any known means. Roentgen believes that the x-rays are longitudinal vibrations of ether of extremely small wave lengths. These rays penetrate paper, wood, leather, glass, and even thin sheets of tinfoil. Lead is quite opaque to the x-rays. The human flesh permits the rays to pass readily, but the osseous structures throw a decided shadow on the fluoroscopic screen. . It is this latter phenomenon of the x-ray that interests the medical world, and has become so useful in the diagnosis of foreign bodies, fractures, dislocations, and various other conditions.

Roentgen made the observation, also, that sensitized plates are affected by the x-rays in the same way as by ordinary light, and he discovered, further, that it is not the fluorescence that causes the changes in the plate, but the x-rays proper. The tube can be wrapped in sunproof paper, yet the photographic plate will be affected, even if placed three or four feet away from the tube. Plates, in fact, become fogged when kept in the same room where the Roentgen tube is in action.

While it is admitted that the source of the x-rays are the cathode rays, emanating from the negative or cathode pole of the tube, Roentgen maintains that the x-rays are developed at the point where the cathode rays impinge on the side of the wall of the tube, or on the anticathode; and, when the particles of matter flying off from the cathode with extreme velocity strike an object in the tube, a new ray is produced which has the peculiar property of penetrating objects opaque to ordinary light. In the original Crookes tube the x-rays were produced at the point where the cathode rays struck the glass wall of the tube. It was soon found that, if the tube remains in action for some little time, the glass at the tube becomes hot from the bombardment of the particles of the cathode ray against it. After a while the glass would soften, and atmospheric pressure would puncture the tube. As the cathode rays travel in a straight line, the anode of the tube was later made to be the target for the cathode rays, to spare the glass from frequent punctures. This latter device was of extreme importance, because, whereas before the x-rays were given off from the entire tube wherever the tube was struck by the cathode rays, now the x-rays emanate only from the target, thus concentrating the rays materially.

A very important advance was made by Mr. Herbert Jackson, of England, in making the x-ray tube a proficient instrument, by placing the anode in the center of the tube and making the cathode a concave disk, instead of a flat surface. The concave cathode disk has the effect of bringing the cathode rays to a focus. In this focus the anticathode (or anode) is placed at an angle of nearly forty-five degrees. The anode is made of platinum to withstand the tremendous heat which develops at this point. The x-rays emanate from this point in the shape of a cone. Not the entire cone of rays is of the same intensity, for the rays of greatest intensity are in the center of the cone. This cone-shaped arrangement of the rays is responsible for the fact that, in taking x-ray pictures, if the plate is brought too near the tube it will cause enlargement of the object skiagraphed. To avoid such a distortion it is necessary to have the plate about twenty inches from the anode of the tube. At this distance the rays begin to be a little more parallel, the angle of the divergence of the rays being now not so great.

Fluoroscopy.—The fluoroscope has proven of great service in medicine, from a diagnostic point of view. In locating foreign bodies it is at times superior in value to the photographic plate. In locating, for example, a foreign body in the esophagus, the fluoroscope cannot be equaled by the plate. In fact, in chest examinations this instrument finds its greatest field of usefulness. In this region of the body the examination of the various organs in motion will yield considerable information. One must, of course, be thoroughly familiar with the physiologic fluoroscopic appearance of this region of the body before the pathologic appearance can be appreciated. In examining the chest with the fluoroscope, the clavicle, the scapula, the ribs, the heart, the sternum, the vertebræ, and the large blood-vessels, all throw their distinctive shadows on the screen. These shadows necessarily vary in their outline and form according as they are viewed from different angles. A side view will differ from that in front or back. These shadows will also differ in different individuals. The lung tissue admits a ready penetration of the x-rays, and any deviation from this transparency points to congestion, infiltration, or some other pathologic changes in the lung tissue. The fluoroscope will find a useful field in the diagnosis of incipient tuberculosis. The position of the heart admits of being outlined with the fluoroscope, and the size of the shadow will assist in determining the degree of its hypertrophy or dilation. The extent of the shadow of the aorta and large blood-vessels in this region will determine the presence of an aneurism. The fluoroscope has been pressed into service to locate gangrenous areas in the lung tissue with much success. It is difficult to appreciate what it means, both to the patient and surgeon, to be able to locate these areas with precision, for it becomes a comparatively small matter to drain an area in the lung tissue if the abscess or gangrenous spot can be located. On physical examination alone one cannot rely positively for the localization of these pathologic areas. Neither palpation, percussion, nor auscultation can be compared in value to the information that sight will give. True, with the fluoroscope we only see a shadow, but location of these shadows is all we need to know. Pleuritic effusions and pus collections can be seen with the fluoroscope with surprising clearness. Foreign bodies in any part of the chest can be located, and their extraction need not become so hazardous an operation under the guidance of the fluoroscope. In searching for foreign bodies the plate should also be pressed into service. By taking skiagraphs at various angles the location of the foreign body can be determined more accurately. The same is true of foreign bodies in the abdominal cavity. Foreign bodies in the stomach and intestines, such as buttons and pins swallowed, can be located with the fluoroscope and their progress through the intestines watched; or, if arrested, their location noted, making the extraction by the surgeon a comparatively simple matter. It is no small comfort for the surgeon to watch his Murphy button coursing through the intestinal tube.

Quite characteristic is the fluoroscopic picture of the upper abdominal region. The liver, spleen, kidneys, and the pancreas, in part, give shadows, the form and outline of which should be studied under physiologic states. The up-and-down motion of these organs with each act of respiration is not without interest. During pathologic states these rhythmic excursions of the organs of this region are disturbed, and we may be assisted by the fluoroscope in establishing a diagnosis. Disease of this region of the body, a space scarcely larger than the palm of a hand, offers considerable difficulty in diagnosis, and if the fluoroscope and plate promise ever so little in clearing up a diagnosis, it surely deserves recognition and skilled application.

The large abdominal blood-vessels and lumbar vertebræ have also their distinctive shadows on the fluorescing screen, and aneurismal enlargements may thus be studied with the fluoroscope. The fluoroscope is of great service in affections of the joints, and here in some respects it will give more valuable information than the plate itself, because a joint can be examined in its various motions, particularly in dealing with foreign bodies in this cavity. In fractures and dislocations in this region, as well as in others, the plate will give more accurate information. A fluoroscopic examination of a fracture, while it may give valuable information, will never compete with the information that a plate offers, and, furthermore, a plate remains a permanent record—a consideration of no slight importance when treatment is to be instituted. If displacement of fragments exists, with a radiograph at hand their proper reposition is greatly facilitated. In fracture cases when the splints are in position, or plaster cast applied, the fluoroscopic examination will show the success of the efforts at reposition.

Before dismissing the subject of fluoroscopy a note of warning should be given to the operator not to neglect to note the time of exposure, lest he expose the subject too long, and unintentionally cause a dermatitis. By noting the time, he is not so apt to overexpose his subject.

Skiagraphy.—Our knowledge of bone injuries has been immensely enlarged since the discovery of the x-rays, and this can readily be understood when we consider the fact that to the sense of touch has been added the sense of sight in dealing with bone injuries. We are able with the aid of these rays actually to see the damage inflicted. Necessarily, not alone the diagnosis, but the method of treatment, has been vastly enriched by the x-rays. A properly executed skiagraph, taken at a proper angle, will lend a wealth of information about the bone injury. It will show the fracture clearly, it will give precise information of the position of the fragments of the displacement, and to what extent the fragments themselves have been damaged. A simple fracture of a bone is amenable to treatment, which requires the observance of but one essential point, viz: immobilization. Not so, however, with a fracture where bone has been crushed, where the fragments have become displaced, and possibly pieces of bone chipped off. Here immobilization alone will not suffice. Proper reduction followed by immobilization is necessary. It is in these serious and complicated conditions of injury that the Roentgen rays illuminate so brilliantly the pathologic field. Here most complicated manipulations will be called for to remedy the prevailing conditions. Intelligent and carefully executed reposition of fragments and correction of displacement and deformity are only possible under the leadership of the Roentgen rays—a light that shows the heretofore invisible and points out the heretofore unknowable. In these complicated injuries the fluoroscope should be pressed into service, and the examinations made in the various planes so as to become acquainted with the entire field of injury. Only in this manner can a mental picture of the entire injury be obtained. In taking an x-ray picture the skiagraph will only show a shadow of one plane of the object. While some fractures will show up well in one picture alone if the proper plane is caught, it is not advisable to rely upon one skiagraph in all cases. Each fracture should be skiagraphed in at least two planes; if possible, one at a right angle to the other. Indeed, in some bone injuries it may be necessary to skiagraph in three or four different planes before the proper extent of the injury can be elucidated. In some regions, like the shoulder, for example, it is not possible to skiagraph so that one plane should be at right angle to the other, because the body will not permit such a position. Under these conditions an anterior and a posterior plane

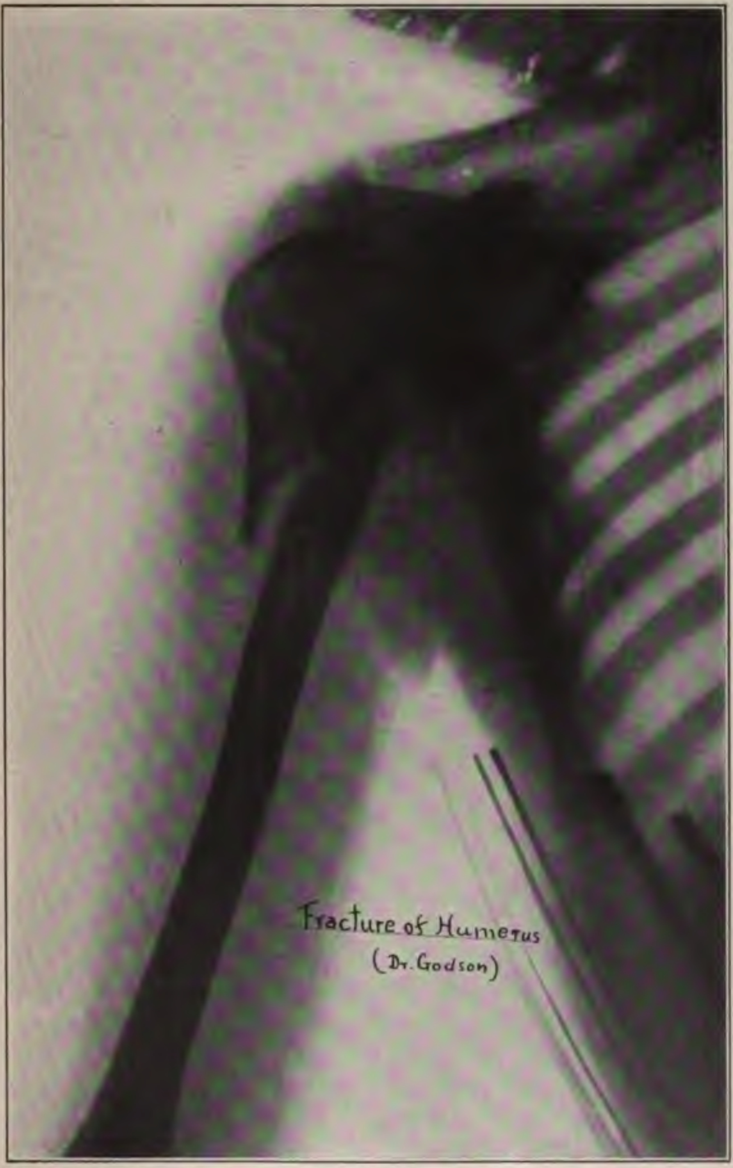


PLATE XXIII.—Skiagraph in a Case of Fracture.

can be taken, or else one picture taken at an acute angle. Indeed, in a fracture of the surgical neck of the humerus, a picture taken at an acute angle, with the plate resting on the scapular region, and the tube in front of the patient at an acute angle to the plate, will show markedly the usual displacement of the upper fragments. It will show the displacement somewhat exaggerated, but the picture will give one an excellent idea of how best to reduce the displacement. In these complicated fractures the reposition, if possible, should be done under the guidance of the fluoroscope. Particularly is this method of reposition to be advocated when fractures involve structures that enter into the formation of a joint. Displacement of fragments that would be of little significance in other parts of the body, and would not cause impairment of function, when they occur in the joint may turn out to be potent agents in causing serious functional derangement. The ingenuity of the operator will be taxed quite frequently to determine what plane of the fracture to depict on the plate to show up the fracture to the best advantage. This can best be discovered by making a thorough fluoroscopic examination before deciding on the plane for the skiagraph. In certain injuries it would be impossible to do this. Under these conditions we must rely wholly on the skiagraph alone. For example, in injuries of the hips a fluoroscopic examination can scarcely be carried out; in injuries of this nature, a skiagraph taken with the patient lying on the back, and a second one with the patient on the abdomen, will give us all the data necessary for a diagnosis; and the study of these two pictures will suggest other modifications in the position, should such change be necessary.

In severe and complicated fractures it is a wise procedure to obtain a skiagraph of the normal or sound side. By doing this we have a plate of the normal x-ray appearance, and it will be of excellent service for comparison with the injured or pathological side. Indeed, in medico-legal cases this should not be neglected, because in this way even the uninitiated can be made to understand the difference between the two negatives.

Technique of Skiagraphy.—In taking a radiograph, the subject, the tube, and the plate must be in a certain relation. The part to be taken must rest against the film side of the plate and be situated between the plate and x-ray tube. As our source of the light is from the anode of the Crookes tube, we should place the anode parallel to the plate, so that the surface of the latter should receive an equal quantity of rays. The whole surface of the plate, as it were, should be bathed in the rays coming from the anode. The region that is to be the point of particular search should be opposite the center of the plate, and an imaginary line drawn from the center of the anode should pass through the center of the sensitized plate. The distance of the anode of the tube from the plate should be about 20 inches. In this space of 20 inches should be placed the part to be exposed. In making a shadowgraph of the chest and abdomen, the distance of the anode from the plate will have to be increased, as in some subjects the diameter of these parts will be almost 20 inches. Under such conditions the tube should be set about 8 or 10 inches from the skin of the subject. It is very essential to make the patient as comfortable as possible during the exposure, as otherwise the patient will not be able to keep the part quiet long enough to obtain a satisfactory picture. Particularly is this the case when x-ray pictures are taken with the static machine, for the exposures are then very much longer than with the induction coil. The degree of the vacuum of the tube should be determined before an x-ray picture is to be made. If the bones of the hand show up partly black, the tube is low enough for radiography. In fact, if two or more pictures are to be taken with the same tube, before each one of the exposures the tube should be tested. The tube being in good condition and the patient and the plate in proper position, the current is turned on and the proper exposure made.

Time of Exposure.—The length of time required for exposure in order to obtain a good skiagraph will naturally vary materially with the region to be x-rayed, and with the subject under consideration. The shoulder of one subject may require less exposure than the elbow of another. It is the amount of tissue, adipose or otherwise, that the rays have to penetrate that must be taken into consideration. The capacity of the machine with which the operator is working must also be recognized. For example, an induction coil, the primary core of which will take 30 ampères, with a good working tube, will generate a volume of x-rays far above that of another, say, with only a capacity of 12 ampères. The length of time of the exposure in the latter case must necessarily be increased, in order to get a radiograph of the same density and clearness as in the first instance. The vacuum of the tube, also, being such a variable entity, is a factor that must be dealt with constantly. Some tubes with an induction coil of less capacity will do better work than another tube of less efficiency, but attached to a machine of a larger capacity. The volume of current that the tube can use up, so to say, is the factor that determines the resulting richness of x-rays. With an *induction coil* of, say, 15 ampères' capacity, and a good working tube, the time of exposure of the various regions of the body should conform to the following table:—

Hand	5	to	10	seconds
Elbow	10	"	15	"
Shoulder	30	"	40	"
Chest	30	"	40	"
Neck	10	"	15	"
Head	60	"	70	"
Hip	90	"	120	"
Thigh	40	"	50	"
Ankle	8	"	10	"
Foot	20	"	30	"

If a *static machine* is used to excite the tube, the length of time of exposure should be the following:—

Hand	3	to	4	minutes
Elbow	6	"	7	"
Shoulder	10	"	12	"
Chest	15	"	20	"
Neck	10	"	15	"
Thigh	10	"	12	"
Ankle	8	"	10	"
Foot	8	"	10	"

The plate, having been properly exposed, is now ready for the developing solution. It should be at once removed, so that no more x-rays can reach it. It should be protected from heat and moisture, as well as from strong lights.

Foreign Bodies.—The location of foreign bodies by means of the x-ray is at times a simple process, but at other times it may be exceedingly difficult. Only those foreign bodies which cast a shadow will admit of being located by the Roentgen rays. Foreign bodies swallowed by children, or accidentally by adults, can be located fluoroscopically quite readily. Their removal, however, will not be so easy a task. Foreign bodies in the esophagus and other parts of the gastro-intestinal tract will show up very readily with the fluoroscope, and their location can be studied by this means. As a rule, these cases will require specially constructed instruments for their removal. Under the guidance of the x-rays the removal of foreign bodies with these special instruments may readily be accomplished. The greatest difficulty will be encountered with foreign bodies in the larynx, trachea, and bronchi; but even from these locations the efforts at removal have been crowned with success under the x-ray light. Foreign bodies arrested in the stomach and intestines will call for surgical measures for their removal, but even here the fluoroscope will give the operator valuable data as to the location and position of the offending body. Quite another problem arises with foreign bodies in the tissues, such as in bullet wounds or those made by other missiles. Here the localization of the missile becomes an important matter. Take, for example, a bullet that has entered the arm. A skiagraph will show the foreign body by means of a shadow. The question now is: what is the exact location of this body? Is it 1 inch, or more, from the surface? Does it rest on the bone, or is it merely under the skin? There are a great number of methods advised for localization of foreign bodies in the limbs, but the simplest one is the following: Let us imagine that we are dealing with a bullet wound in the thigh. With the fluoroscope we determine the horizontal and vertical planes of the bullet. These two planes are marked on the skin of the thigh with iodine or silver nitrate. With a piece of adhesive plaster four letters made of wire are pasted on the skin at the ends of two imaginary lines passing through the limb in the planes mapped out previously with the fluoroscope. We shall have then the wire letter *A* anteriorly, the letter *B* posteriorly, and *C* and *D* to the right and left of the imaginary line. The limb is now skiagraphed, and the distance of the shadow of the four wire letters from the shadow of the bullet on the x-ray plate will indicate the position and location of the foreign body in the limb. This method of localization, as a rule, will give the surgeon a good idea of the location of the bullet, and he will avoid making unnecessary incision in search for the offending missile. In foreign bodies in the hand, such as pieces of a needle or pin, the following simple method of localization will, as a rule, be sufficient: The hand of the patient is held against the fluoro-

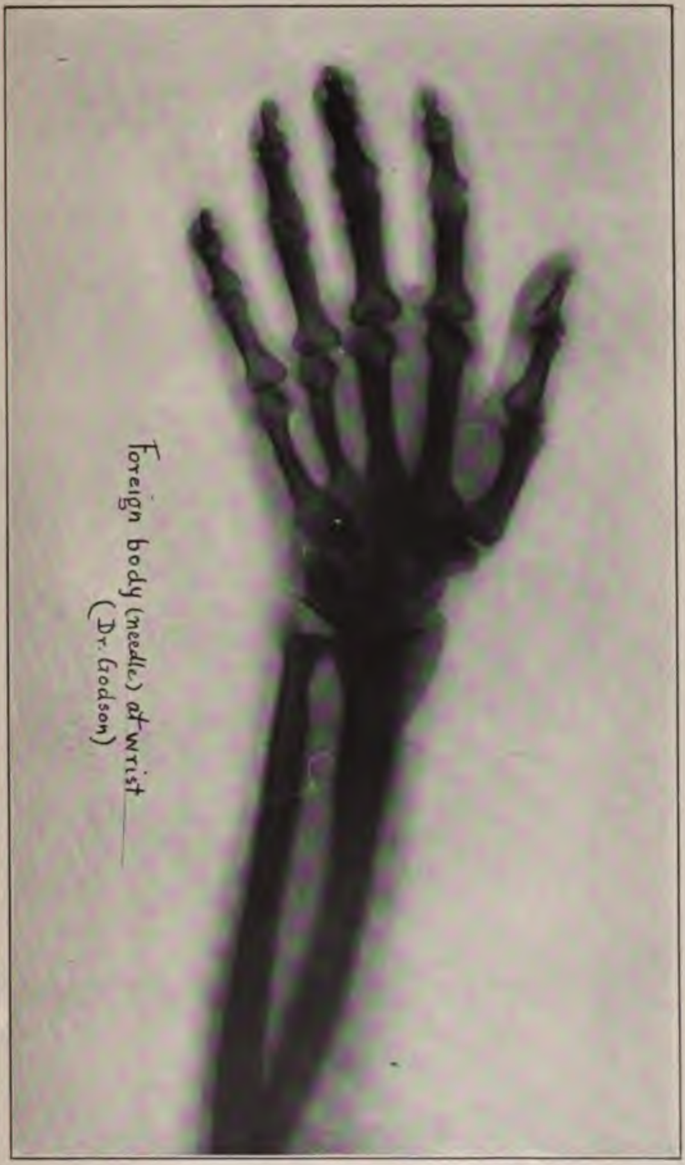
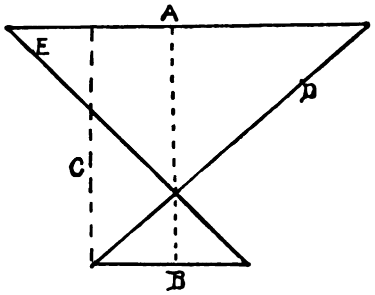


PLATE XXIV.—Skiagraph in a Case of a Foreign Body.

scope, the operator fixes his eye on the foreign body, and moves the fluoroscope and hand of the patient to right and left in front of the x-ray tube. In doing this careful observation will show that the shadow farthest away from the eye of the observer will move more rapidly across the fluoroscopic field. If the palm of the hand is pressed against the fluoroscope, and the needle is lodged between the bone and back of the hand, then by gently moving the hand to right and left the shadow of the needle will be found moving across the field of vision with more rapidity than the shadow of the bone in front of it; and *vice versa,* if the needle is in front of the bone. To verify this, a very simple experiment will suffice: Fasten a needle to the back of the left hand with a piece of adhesive plaster; stand in front of the x-ray tube, and press the palm of the hand against the back of the fluoroscope. It will be seen, on moving the hand, that the shadow of the needle crosses the field of vision much faster than the shadow of the phalangeal bones. Reverse your hand, and the phalangeal bones will travel across the fluoroscope more rapidly. The horizontal plane is then marked out with silver nitrate or iodine. Such data will give much valuable information to the surgeon in removing the foreign body.

In foreign bodies in the chest cavity the problem of localization can be attacked in the following way, utilizing a well-known algebraic formula:—



If two lines are drawn between two parallel lines so as to cross each other, two triangles will be formed, the angles of which are the same. If a line be drawn through the angles, the parts of this line intercepted by the triangles will bear the same relation to each other as the parallel lines, between which the triangles are formed. The equation will now be as follows:—

$$a : b :: c - x : x$$

$$\text{or } x = \frac{b \times c - x}{a} \text{ or } \frac{b \times c}{a + b} = x$$

$$\text{If } a = 6,\ b = 2,\ c = 12, \text{ then } x = 3$$

$$\frac{b \times c - x}{a} = 3 \text{ and } \frac{b \times c}{a + b} = 3$$

It can readily be seen that, if the value of three lines are known, the fourth can be found. The three measurements necessary are the lines *a, b,* and *c;* and their value, by way of illustration, is found in the following way: Take a large book, like Polk's directory or the "United States Pharmacopœia"; place a coin in any part of the book; place the book over a sensitive plate, and make the exposure so that an imaginary line drawn from the center of the anode of the tube should pass obliquely through the book. The distance of the anode from the photographic plate in a straight line should be measured and recorded. Let us say that this distance is 18 inches. This known quantity corresponds to the letter *C* in the above drawing. The oblique line of rays from the anode, above spoken of, represents the line *D* in the drawing. Now an exposure is made long enough to give a good shadow of the coin on the plate. This having been completed, the book and plate should retain their position and the tube be moved to the other side of the plate, in the same horizontal position, so that an imaginary line from the center of the anode should again pass obliquely through the book. This line of rays will correspond to the line *E* in the drawing. The distance between the first and second positions of the tube should now be measured and noted. Say it was 10 inches, this known quantity gives us the length of the line *a* in our drawing. The plate is again exposed for a sufficient length of time. It is very evident from what has been said that, as a result of these two positions of the tube, the rays will cross each other, the same as the two lines *D* and *E* cross each other in the drawing. When the plate is developed it will be seen that the coin has two shadows on the plate. The distance between these shadows on the plate is now measured. Let us say that this distance is 2 inches. Our equation runs then as follows:—

The distance of the tube from plate	18	inches
The distance between the two positions of the tube	10	"
The distance between the two shadows on the plate	2	"

The three measurements being known the fourth is easily found:—

$$2 \times 18 = 36 \div 6 + 2 = 8 = 4\tfrac{1}{2} \text{ inches or } \frac{6 \times c}{a \quad b} = x$$

The coin then in the book is $4\,{}^1/_2$ inches from the surface where the plate was situated during the exposure. A book, however, has three dimensions; hence the position of the coin in all of the three planes must be located. The three measurements thus obtained will give exactly the location of the coin. With foreign bodies in the chest the same method may be used. Here, however, only one picture is really necessary to find out the depth of the bullet from the surface. The horizontal and vertical planes in which the foreign body is lodged can be found with the fluoroscope alone.

Developing the Plate.—There are many "developers" on the market, but the most convenient ones for a physician are those that are put up in small packages ready for use when dissolved in water. The so-called "metol-hydrochinone" developer is as serviceable a developer as any. The chemicals come in two papers, put up like a Seidlitz powder. These two powders are dissolved in 4 ounces of cold water. Hot water would dissolve the gelatin coating of the plate, and therefore no heat should come in contact with the sensitized plate. The powder having thoroughly dissolved, the solution is ready for the plate, and can be put into the tray. If a large-sized tray is used, two or three packages should be dissolved. The quantity of "developer" should be sufficient to cover the plate completely. In a tray for an 8 by 10 plate 8 ounces of developer is quite sufficient. That means two powders. Besides the "developer" a "fixing" solution is necessary. The latter solution consists of saturated solution of hyposulphite of soda—known as "hypo." To a pint of cold water add about 5 ounces of hyposulphite of soda crystals and dissolve thoroughly. This makes the fixing bath. It should be put in the tray, next to the tray with the "developer." The room having been absolutely darkened, and the ruby lamp lighted, the developing may be proceeded with. The plate is removed from the envelope and immersed in the developing solution. Care should be taken to cover the plate with the solution with the first sweep, as otherwise the plate will develop unevenly and result in a faulty "negative." The length of time necessary to develop a plate will depend on many factors: on the degree of the exposure, the parts radiographed, the quality of the plate, as well as the strength of the developing solution. Some plates develop slower than others. The operator will have to gain personal experience on this subject, in order to avoid "overdeveloping" or "underdeveloping" his plate. But for a general guidance this much can be said on the subject: When the plate is first immersed in the solution it is white. Gradually the shadow of the part exposed will appear, and the part not taken up by the shadow will gradually turn brown, and then black. The part taken, however, still remains white. Gradually the white will fade, and this part of the plate becomes brown also. When the shadow on the plate of the object radiographed becomes brown, and the sides of the plate blackish in color, then the plate is fully "developed." The plate is now removed from the "developer" and rinsed off in cold water and at once placed in the "fixing bath." The plate now needs a little further watching. Although the film side of the plate has become brown, the back of the plate, or glass side, is still white. The plate must be kept in the "fixing" solution until this white background disappears, and the entire plate, front and back, becomes brown. The plate now needs to be washed in cold water to dissolve off the "fixing solution." This can be done by putting the plate in a tray filled with water, allowing it to remain in the water for one hour. At the end of this time the plate is removed and allowed to dry. The plate should now be protected from dust, which would adhere to the wet film of the plate. When the plate is dry it remains a permanent record of the part x-rayed, and is called a "negative." From this negative any number of prints may be made on paper, but while the bone in the "negative" shows up white, in the print, or so-called "positive," the bone shows up dark. The developing solution, as well as hypo, may be used again, and these solutions will keep well in tightly corked bottles. Half a dozen plates may be developed in the same solution. After this the "developer" will weaken and should be discarded.

Interpretation of the X-ray Plate.—Nothing needs more care and guardedness in radiography than the proper interpretation of x-ray pictures. Absolute familiarity with the normal x-ray appearance of the various anatomic parts of the human skeleton is necessary before the interpretation of the pathologic is possible. The great majority of fractures will, of course, be easily elucidated from the Roentgen plate, but some radiographs of fractures will not admit such a ready interpretation. If an x-ray picture shows up the fracture, nothing can be more positive in pointing out the injury; but, if only one radiograph is taken of a part and no fracture is shown, it does not mean that a fracture does not exist. An oblique fracture of the tibia, for example, may exist, and an x-ray picture, taken in an antero posterior direction, may not show up the injury at all. Not so, however, if a lateral view is taken. In this picture the fracture will show up well. It is therefore necessary to radiograph an injury in at least two projecting planes. After the plate is developed and dried it should be carefully scrutinized and the relation of parts studied. It is necessary to bestow the utmost care in reading a plate before coming to a definite decision about the case. The position of the parts while on the plate should be considered in interpreting the radiograph. Nor should it be forgotten that an x-ray plate may show decided anatomic defects, and yet the function of the bone may be very good. A faultily united fracture does not necessarily mean bad functional results. This is an important consideration, and must be remembered in interpreting x-ray pictures. When fractures, with little or no displacement, and with little or no subjective or objective symptoms, are radiographed, and the best possible projecting plane of the fracture not caught, the plate may present great difficulty in reading, and, unless the utmost care is bestowed on it, such a plate may be misinterpreted. Vigilance, knowledge of the normal x-ray appearance of bone, and careful scrutiny of well-developed plates will doubtless avoid misinterpretation.

Hand.—The hand is very readily shadowgraphed. The tissues are thin and easily penetrated by the rays. The bones, also, are not massive. In radiographing for injury of this region, the palm of the hand should rest on the plate. Should the fluoroscope, however, show that this antero-posterior plane does not show up the injury advantageously, then the back of the hand may be made to rest on the plate. Indeed, in dislocations of the phalanges, or in foreign bodies in the hand, a side view will be necessary to clear up the diagnosis. In taking a lateral view of the hand care should be taken not to have the shadows of all the metacarpal bones fall on each other, as this would make the plate worthless. By modifying this lateral view a little, and taking the picture at a slight angle, the metacarpal bones and phalanges will show up separately on the plate. The normal hand should be carefully studied, particularly the carpal bones. Here, on account of the irregularity of the bones, certain shadows will be seen on the plate that should not be mistaken for pathologic lesions. The bones entering into the formation of the wrist joint should also be studied in the skiagraph. In Colles's fracture a skiagraph taken in an antero-posterior position may not show the fracture, or, if the fracture does appear, the degree of displacement of the lower fragment may not show at all. It is essential, therefore, to obtain an x-ray picture of the injury in a lateral position. The displacement will then be shown, which, after all, is the important consideration in fracture of the carpal end of the radius.

Elbow Joint.—This joint is best shown in two views: The antero-posterior and the lateral. The relation of the head of the radius to the joint should be noted in the normal condition. The olecranon process of the ulna is best shown in the side view, and, as this part of the ulna is frequently the seat of injury, it should be studied with care. In fractures of the olecranon process, pieces of the bone, becoming detached, may find their way into the joint cavity. This accident does not necessarily produce functional disturbance of the joint. A case of this kind came under personal observation. The patient, a boy of 14, sustained an injury to the elbow joint. The skiagraph showed a fracture of the lower end of the humerus, and also a fracture of the olecranon process of the ulna. A piece of bone detached from the olecranon process lodged, apparently, in the joint. Various manipulations, under the guidance of the fluoroscope, failed to displace the fragment. Reduction and immobilization of the other part having been accomplished, the parents were told that it might be necessary at some subsequent time to remove the fragment of bone from the joint by operation. The fracture healed up well, with complete restoration of functions. Although the fragment can even now be seen in the joint, no impairment of function is experienced by the boy.

Shoulder.—A radiograph taken of the region of the shoulder will show the head of the humerus, the acromion and coracoid processes of the scapula, the glenoid cavity, the clavicle, and, if the radiograph is well executed, also the outline of the scapula, as well as of the ribs. The shadows of these various structures, and their relation to each other, should be noted; also the space between the outer end of the clavicle and the acromion process of the scapula. In injuries to this region the plate should be placed behind the patient, the latter lying on his back, with the tube immediately in front of the patient. A lateral view of the region is best taken with a Roentgen tube at an angle with the plate. By doing this, in case a displacement of the upper fragment exists in fracture of the surgical neck of the humerus, such a deformity will show up well, and subsequently, when proper reduction has been accomplished, another skiagraph taken at the same angle will show the improvement very vividly. In fractures of this region the tendency to overriding is very great, and it is no small problem to keep the fragments of the bone properly reduced. With the aid of the fluoroscope, however, the treatment of these fractures becomes much simplified. Occasionally it will be necessary to take a radiograph of the shoulder region with the patient lying on the abdomen, but, as a rule, an antero-posterior and lateral view will be sufficient to show up injuries of this region on the plate.

Chest and Neck.—The chest and neck may be well illustrated in the radiograph when taken in an antero-posterior position. The ribs show up well, and in a good plate the curves of the ribs will also show up well. The sternum, the shadow of the heart, and the shadow of the large vessels can be studied from the front view. In this anterior view the ribs of the front region of the chest also will show up well. Should it be desired to bring out the posterior section of the chest on the plate, the patient had better lie on the stomach, with the plate against the chest wall. The shadow of the mediastinum on a plate taken from behind forward will, of course, be different than a plate taken from before backward. The position of the clavicle in these two pictures should be noted. The neck may be radiographed from the front, back, and sides. In a front view the bodies of the vertebræ will show up best, as well as the transverse processes. In a posterior view the arch of the vertebræ will be best depicted, while the lateral view will show the spinous processes best. In locating foreign bodies one or all of these positions may be necessary before a proper localization of the body is admissible.

Abdomen.—The skiagraph and fluoroscope have been pressed into service to assist in the diagnosis of calculi of the various abdominal organs, as well as in foreign bodies in this region. The diagnosis of calculi in the various abdominal organs is often attended with difficulty, and under many conditions no diagnosis of calculi can be established. It is therefore of no small moment to have such an important means of diagnosis at hand as the x-rays have proven to be in at least a limited number of cases. Gall-bladder calculi have been diagnosed with the Roentgen rays in a sufficient number of cases to justify exposure of the patient to the rays in all cases of suspected cholelithiasis. The patient is to lie on the abdomen and the plate is to include the epigastric and right hypochondriac regions. When the plate is developed it should have on it the vertebral column and lower ribs. This is essential, as otherwise the plate will not admit proper interpretation of the anatomic regions. This same arrangement of the plate is necessary in skiagraphing for renal calculi or ureteral calculi. The difficulties attending skiagraphy of calculi should not be underestimated. While success has crowned efforts at diagnosis of calculi with the rays, failures have been frequent. It is a most difficult matter to choose just the proper kind of tubes for these exposures. A low tube should be used, and yet the tube must be sufficiently hard to give good penetration. Certain kinds of calculi can be more readily skiagraphed than others. The calculi consisting of mineral matter throw a deeper shadow, and hence register better on the sensitized plate. The diagnosis of vesical calculi is not attended with as much difficulty as that of calculi of other organs. The exposure can be made in two positions: The patient may be in a semirecumbent position with the plate under him, so placed that the outlet of the pelvis, as it were, is covered by it. Or else the plate may be placed over the lower part of the abdomen and the tube behind the perineum, so that an imaginary line from the anode of the tube to the center of the plate would pass through the center of the pelvic cavity. A low tube should be used. The pelvic bone should be distinctly visible on the plate.

In radiographing for calculi no opinion should be expressed on one shadowgraph alone. The diagnosis should be based on at least two or more pictures. The danger of being mistaken about the shadows on the plate in these cases is very great. The interpretation of these shadowgraphs is exceedingly difficult. Intestinal contents may throw shadows on the plate that may be mistaken for calculi. Again, calculi, for example, in the kidneys or ureters, may cause decided subjective and objective symptoms, and yet the smallness of their size will prevent their successful skiagraphing.

Pelvis and Hip Joint.—In taking an x-ray picture of the pelvis it should be noticed that the rays have to penetrate masses of tissue, and therefore it is necessary to have the machine and tube in proper working order, or else failure is inevitable. With the patient on the back, the anode is made to point just a little above the symphysis pubis. A picture taken in this manner will show the pelvic bone, the sacrum, the coccyx, the symphysis, the ischii, and the obturator foramina. Fractures will show up well, as also will foreign bodies, in these pictures. It may be necessary at times to skiagraph with the patient lying on the abdomen. Indeed, in certain conditions this position becomes imperative in order to bring out certain details in the picture. In congenital dislocations, as well as in injuries of the hip bone, the same two positions, the anterior and posterior, are necessary to be assumed by the patient in taking an x-ray picture, except that here we place our anode over the hip joint region so as to bring out those structures to the best possible advantage. In old people who have sustained injuries to the hip bone it will be found to be quite a task for them to lie on the abdomen, and therefore only after the x-ray picture taken on the back fails to clear up the diagnosis should they be subjected to the hardship of having to lie on the abdomen. In some cases the anterior position will be quite sufficient to clear up a diagnosis. A low tube should be used, and the exposure should be short, with the current on to the fullest capacity of the induction coil. The most practical way to deal with these hip injuries in old people is to bring the x-ray apparatus to the bedside, slipping a piece of board under the injured part, over which the sensitized plate is placed. In this manner these old patients are saved much suffering, and they need be scarcely disturbed from their comfortable position in bed. At least two or more pictures should be taken, as the interpretation of plates of hip injuries becomes at times exceedingly difficult.

Thigh.—The thigh is more readily radiographed than the hip. A low tube should be used and the exposure made short. For injuries of this region the anterior, the posterior, and the lateral positions will be most serviceable, and the injury will show up well on such plates.

Knee.—The knee should be skiagraphed in a lateral position, and also in the anterior. To show up the patella well, the knee should be bent and the side view exposure made. If the lower end of the femur is the object of investigation, as in tuberculosis, a front view will be the most serviceable position. This same position will also show up the head of the tibia. In injuries and foreign bodies of the knee joint special positions for the shadowgraph will readily suggest themselves when a careful fluoroscopic examination is made of the patient.

Ankle.—The ankle joint and foot can be very readily x-rayed and, as a rule, the pictures turn out well. In Pott's fracture the skiagraph should be taken in such a position as to show up both bones on the plate. If the shadow of the tibia should be thrown over the shadow of the fibula, or *vice versa,* there might be a confusion in the interpretation of the plate. A front view should therefore be taken. The plate is placed behind the heel, and the tube is in front of the leg. In a picture obtained in this position the styloid processes will show up well, and their relation to the ankle joint is also well shown. A lateral view, however, is indispensable, and should never be neglected in these injuries. Displacements, as well as fractures, will show up in these two positions to the best advantage. Here, as well as in other regions of the body, when dealing with foreign bodies, the position for an x-ray picture best suited to that particular case will suggest itself while making a fluoroscopic examination.

Foot.—In studying the various bones of the foot an x-ray picture taken with the sole resting on the plate will be most serviceable. This is also true of the tarsal bones. In dislocations, however, a side view is also necessary. The foot, like the hand, should be studied skiagraphically under normal conditions. The various bones in this anatomic part differ so in their density and outline that only a thorough familiarity with the normal appearance will permit a safe interpretation of the pathologic state. The various joints of the tarsal bones and their peculiar shadows should be the subject of the study in the normal plate. Only in this way can dislocations and fractures of these small bones be properly interpreted. Furthermore, the diagnosis of fractures of these small bones can only be made with the x-rays. Injuries to these small bones are quite frequent, and the diagnosis is very puzzling without the aid of the Roentgen rays. Nor is the occurrence of foreign bodies in this region of the body so infrequent. Indeed, after that of the hand, the foot is the most frequent seat of foreign bodies accidentally introduced. The localization of these bodies is best made on the lines suggested in dealing with foreign bodies in the hand.

RADIOTHERAPY.

New therapeutic measures when they first appear on the medical horizon are apt to be lauded to the skies, and the fantastic visions of the medical enthusiast encircles them with wreaths of exaggerations and dreams. Radiotherapy was no exception to this rule. However, this extreme enthusiasm about x-ray therapy was, in a measure, pardonable, when it is considered that with its aid the therapeutist undertook to cope with diseases most formidable in nature and fatal in effect. The medical world was thrilled and startled to have at its hand so powerful a therapeutic measure as the Roentgen rays. There was something ideal and fascinating about this curative agent. To be able to make remedial applications without causing pain or the slightest discomfort to the patient, and to observe definite and positive results from these applications, so devoid of even the least amount of discomfort, was indeed enough to fire the enthusiasm of both physician and patient. While there has come a reaction to the great enthusiasm in x-ray therapy, there remains still, after these years of trial, that conservatism in the application of this remedial measure that will establish it on lines that will be lasting. Strip from this therapeutic measure those exaggerated claims made for it in the heat of enthusiasm, weed out the chaff, and there still remains in it much that is good and wholesome, much that will cure most fatal maladies, much that will give relief from suffering, and much that will conduce to the happiness of mankind. Are there many other remedial measures that will do this? There are, indeed, but a few. It is no disparagement of x-ray therapy to say that it is not a panacea for all human ailments. Nothing like a panacea has ever been found in real life. Panaceas occur only in dreams. But that the range of therapeutic applications of the rays is surprisingly great, and that it is still widening, must be admitted. And, indeed, such a wide range of applicability of the remedy is to be expected when it is considered that the x-ray is capable of allaying pain, bringing about most remarkable tissue changes, hastening the absorption of exudates, breaking down adventitious cells that invade normal tissue, and causing degeneration of neoplasms. That it has not the power or virtue in internal cancers that it has in malignant growths of the integument is greatly deplored, and yet even in deep-seated cancers it will bring degrees of comfort to the patient that forces this remedial agent into the foremost ranks of therapeutic measures. Were the Roentgen rays to do nothing more than bring about a cure in rodent ulcers and certain epitheliomas (and this it can do beyond any doubt), it would, for this one reason alone, deserve to be placed among the important therapeutic measures. The x-rays have triumphed over lupus vulgaris and erythematodes, bringing about permanent cures in these affections. It has been successfully employed in various skin affections. It is most interesting to watch how a chronic eczema that has existed for years, and resisted all measures of cure, yields so readily and frequently in a permanent manner to a few applications of the Roentgen rays. Eight months ago in a case under our care an eczematous patch of seven years' standing yielded to half a dozen exposures, causing the disappearance of the eruption, softening the skin, and causing a final complete restoration of the skin in texture and appearance. The Roentgen rays have been employed therapeutically in sycosis, hypertrichosis, favus, blepharitis, acne, psoriasis, alopecia, eczema, carninomatous and sarcomatous areas, Hodgkin's disease, and in neuralgia. As an experiment it has been used in tuberculosis and rheumatism.

It must be admitted that the Roentgen rays have a vast amount of therapeutic value in them, but, like all remedial measures, their application requires that fine discrimination which is the attribute of the careful therapeutist. It should be measured out in doses like all other curative agents. To be able to do this the operator must be thoroughly familiar with the apparatus and the peculiar effects the Roentgen rays have on animal tissue. Furthermore, the x-ray exposures at first must be tentative, to discover the so-called idiosyncrasy of the patient. There can be no doubt that with the same apparatus and tubes, and the same length of time of exposures, one person will be only tanned, while the next one will have a first degree of dermatitis. In some cases tanning will produce the desired therapeutic effect with this agent, while in other cases nothing short of dermatitis will suffice to bring about success. It is here that the discrimination of the therapeutist determines success or failure. Take a case of acne, for example. When there is much tissue infiltration about each pus tube or follicle, the amount of exposure necessary to bring about a cure may be such as to fall just short of a dermatitis. In another case, where the tissue infiltration about each focus of infection is not so great, very little raying will be sufficient. In rodent ulcers or lupus the same will hold good: in one case, exposures falling just short of a dermatitis will be desirable, while in another case tanning alone will be sufficient. In superficial lesions a low tube is desirable to use—low enough for radiography. Not so, however, when internal cancers are to be affected. Here a much higher tube is necessary. The tube should be high enough to penetrate the skin and reach the malignant neoplasm. Indeed, this fact, that we have to traverse the skin with our rays in treating internal cancers, is an important consideration. The question may well be asked: Why are not malignant diseases situated beneath the skin as amenable to cure by means of the x-ray as these same conditions found on the skin surface? It may be, of course, that the malignant process in an internal organ differs in its histogenesis from superficial cancers. Yet it is more likely that the failure is due to the fact that it is impossible to bathe the tumor with the rays sufficiently in internal organs to bring about those desirable changes that make for a cure in a neoplasm situated so as to receive abundant rays. Even in cancer of the uterus, where there is much more access to the organ than in other situations, we are hampered in raying the organ to the fullest capacity. To reach the fundus properly with our rays the ray must pass first through the abdominal walls. Try as we may, we cannot irradiate an internal organ as effectually as we can the skin. While it is true that the curative action of the x-rays depends in a large measure on the amount of rays given to a part; the disappearance of a malignant tumor does not depend on the amount of rays that the individual will take. It depends, after all, more on the nature of the neoplasm and the situation of the same. Some malignant neoplasms simply will not be influenced by the rays. Why that should be the case is difficult to understand. Again, sarcomas will yield more readily to the Roentgen rays than carcinomas, and yet sarcomas of bone are not very hopefully affected by x-radiations. Furthermore, carcinomas of very vascular regions, like the anus and rectum, will be most obstinate in their behavior toward the x-rays. An exception to all this should be made and the x-rays should be most encouragingly spoken of in carcinoma of the mammæ. In carcinoma of the breast the x-rays will prove very serviceable, if not a life-saving measure. Of course, a sufficient time has not elapsed to justify much enthusiasm on this subject, but the recorded cases up to date lend considerable encouragement to the hope that in carcinoma of the breast, x-rays, in conjunction with surgery, will accomplish more in eradicating the disease than has been the case heretofore. It is a lamentable fact that in carcinoma of the breast a recurrence after operative interference, even in cases where operation is undertaken early, takes place in more than 50 per cent. of the cases. This is true even in the most favorable cases, where the most radical operation is carried out. The hope is entertained by those who have given the subject attention that the percentage of recurrences in carcinoma of the breast is less when the rays have been used before and after operation than when the neoplasm is attacked by operative means alone. Whether this hope will be realized fully, or whether barren regrets will follow it, only the lapse of time can determine. However, so earnestly is this observation launched by those who have given the subject attention that, in view of the dire results of recurrence in this affection following the knife, it is but justice to the unfortunate patient that she should have the benefit of the doubt and be subjected to x-ray treatments before and after operation. The question may be asked: What is the rationale of such a treatment? Is there a rationale, or is it mere empiricism? The rationale of it is simply this: The Roentgen rays bring about certain tissue changes whenever they are applied to a part for a sufficient length of time. Just in what manner these tissue changes come about is not understood, but pathologic investigation seems to point to definite changes that occur in the blood-vessels of the part subjected to the rays, and therefore it is believed that these changes in the cells are due to disturbances in the nutrition of the cells. It is, indeed, likely that the cell changes are due to the direct action of the x-rays on the protoplasm of the cells themselves. Furthermore, the cells of low vitality will be more affected by these rays than normal tissue. Perhaps the ether vibrations in the tissues set up by the rays are the causative factor of the cell degeneration. Be this as it may, remarkable tissue changes are brought about by the rays. In raying a carcinoma of the breast what happens is this: The cancer cells that infiltrate the organ, being of lower vitality than the cells of the surrounding normal tissue, break down and are absorbed into the circulation, and thus eliminated from the system. The same fate awaits those cells that infiltrate the glands. If this is the *modus operandi* of the Roentgen ray on tissue cells, then it is a very rational way of attacking the problem of cure, because the remedial measure has really a sort of selective action for the cancer cells, if the raying is not carried beyond a certain point. If exposures are carried on beyond this point, not alone the cancer cells, but all tissues x-rayed will suffer a like fate. Having arrested the growth of the tumor by means of the rays, the surgeon is then called to remove the offending neoplasm. This saves the patient much suffering, if not a dangerous toxemia, which may happen by removing the tumor by absorption alone. The neoplasm having been removed and the wound having healed, the parts and the whole region of the chest are again subjected to x-radiation, so as to rid the patient of any lurking cancer cells. If this is the true rationale of the treatment, it will be readily seen that success can only come, in a final cure, if the case is treated early, before dissemination of the cancer cells, or invasion of the mediastinal glands has occurred. Once these deeper glands are invaded by the cells of the neoplasm, then neither the knife nor the x-ray, alone or combined, can possibly rid the patient of the malignant process. It is advisable to precede the operative interference in cancer of the breast with x-radiation, for the reason that, by exposing the patients at once to the rays on their presenting themselves, further growth of the tumor is stopped. This is evidenced by the shrinking of the neoplasm after a few rayings. The retracted nipple becomes less bound down, the enlarged glands diminish in size, and a retrograde metamorphosis in the parts is plainly visible. Such is the condition that is brought about by the x-rays, and now the case is ready for operation. The manipulations of the surgeon now will not dislodge and force into the lymphatic vessels and circulation active cancer cells, and thus favor metastasis and recurrence of the neoplasm. The cancer cells that are dislodged by the surgeon's manipulations are not active because they have undergone a retrograde metamorphosis. Furthermore, the lympthatic glands that harbor the cancer cells, derived from the neoplasm under the influence of the rays, are stimulated to activity, the parasite cells they harbor degenerate, and thus these lymphatic sentinels rid themselves of the infection. Not so, however, when the glands of the mediastium have become involved. Here the Roentgen rays cannot reach the glands in sufficient concentration to destroy the cancer cells they harbor. The osseous structures and large blood-vessels prevent the rays from reaching these infected glands. Besides, if the infection has already reached the glands in the chest cavity, the dissemination of the cancer cells has probably occurred to an irreparable extent. Such a dissemination must necessarily prove fatal. Neither surgery nor radiography, alone or combined, can rescue the patient from the malignant snare.

In radiotherapy it is important to remember that the Roentgen rays have a destructive action on the hair. If a hairy part is exposed a few times the hair will begin to fall out, and great disfigurement may be inflicted on the patient. Fortunately, we can guard against this by protecting the hairy portions of the body with tinfoil or sheets of lead. Tinfoil in two or three layers will absorb the rays and prevent their action on the hair follicles. In raying the region of the face, the head, eyebrows, mustache, and beard can be protected by placing suitable pieces of the protecting metals over the parts. Shields may be used to protect the whole region of the body, except the part or area to be x-rayed. In treating a case of acne, for example, the eyebrows and lashes are covered with pieces of tinfoil cut into suitable shapes and sizes. The shoulder may also be protected with shields made of thick rubber. In fact, wherever circumscribed areas are to be rayed, the rest of the body should be shielded from the rays. Take, for example, the raying of a fatty tumor in any part of the body; it would be entirely unnecessary to ray the surrounding tissues, because we simply wish to cause a degeneration to occur in the tumor itself, and thus remove it by absorption. The surrounding tissue need not be rayed, and there is no need of running the risk of dermatitis. Not so, however, in raying for malignant disease. Under these conditions, no part should be protected from the rays, except the head, eyebrows, and lashes, and even these parts should be sacrificed if the neoplasm is in these regions. Should the neoplasm be in the breast, for example, it will be just as well to protect the hair on the head, eyebrows, and lashes from the rays, as it would be quite unnecessary to disfigure the patient. Further shielding, however, in malignant diseases than that pointed out would defeat the object in view in raying. In malignant disease we wish to ray as wide of the neoplasm as possible and administer as much of the rays as is safe. There is a limitation to the amount of raying. Indeed, were there no limitation to this therapy, most tragic and startling effects could be produced by the therapeutic agent. The radiotherapist must forever be on the watch for a dermatitis and auto-intoxication. These are two conditions that put the limitation on radiotherapy. The integument will stand just so much raying, and the amount of exposure the skin of a patient will stand is a personal equation; it varies with each patient. When radiotherapy is undertaken, the idiosyncrasy of the patient must be discovered first by tentative means. Great circumspection is also necessary as regards auto-intoxication. This results from the absorption of poisonous material derived from broken down tissue product. The symptoms are the same as in auto-intoxication. There are malaise, aches and pains, chills and fever, at times the rise of temperature being quite stormy. Only by keeping constant watch on the patient can we discover these early symptoms of dermatitis and toxemia, which tell the observer that we have reached the limit of our radiotherapy in that particular case, for the time being. If exposures are persisted in in view of these symptoms, not alone will our therapy be nullified, but great suffering may be inflicted and harm to the patient ensue. Overzealous radiotherapy is to be avoided and condemned. It does great damage to the cause of radiotherapy and the art of medicine. Moderation, experience, circumspection, and caution are the watchwords in radiotherapy, as, indeed, they are in all therapy.

X-RAY DERMATITIS.

X-ray burns, like ordinary burns, are of various degrees of severity, the first degree being that of tanning of the skin with desquamation, and the severest that of circumscribed and deeply diffused gangrene of the skin. Between these two extremes degrees of x-ray dermatitis there are gradations and variations. A moderate degree of dermatitis may be beneficial for therapeutic purposes, but the severe third degree of x-ray burns should, of course, be avoided. The process of repair in these severe cases is very slow, and the suffering of the patient not inconsiderable. In the first degree of burn we have hyperemia; in the second degree, blisters; and in the third degree, gangrene. The operator should never neglect to inquire of the patient about sensations experienced in the region that is being x-rayed. The first symptom of an impending x-ray burn is a sense of tightness in the region irradiated; following this sense of tightness, and at times coincident with it, there may be itching of the part, redness, and a sense of heat. In the presence of such symptoms no further exposures should be made until these symptoms subside. This may take a few days or as many weeks. Nor should the fact be lost sight of that a dermatitis may not develop for two weeks after exposure, though such a long interval between exposure and the appearance of the dermatitis is rare. Usually, within a week the dermatitis will develop after a lengthy exposure. In a case which came under my observation an exposure of fifteen minutes with a static machine was followed by a first degree of dermatitis eighteen days after the exposure. In view of this fact, one can readily see in what difficulty we labor when considering the subject of the susceptibility of the patient to x-rays. When treatment is undertaken the first exposure should be short—say, two minutes with a coil and ten minutes with the static machine. This is repeated for a few times, every other day. Then an interval of four or five days is given, to see if there is a tendency to dermatitis. If such proves to be the case, the raying is discontinued; if not, another exposure is made—still a short one—and three or four days is allowed to pass by. If at the end of this time no symptoms arise that would lead one to suspect trouble, the exposures can be prolonged, but the case should be continually watched. The watchword of the radiotherapist as regards dermatitis, is Vigilance! Vigilance! Vigilance!

APPENDIX.

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA, WITH DETAILS OF TREATMENT AND ULTIMATE RESULTS.

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT.

No. of Case.	Referred By or Treated At	Age of Patient.	Known Duration of Growth.	Description of Growth.	Clinical Symptoms.	Method of Treatment.	Results.	Time After Cessation of Treatment When Results Were Verified.
1		45	4 years.	Interstitial growth, size of cocoa-nut, projecting into right broad ligament.	Pressure on bladder and menorrhagia.	Buried puncture, —, 60 to 200 ma. at intervals of a week, followed by intra-uterine.	Sympt. cure and early reduction of size one-third. Recent report of patient says growth has disappeared.	16 years.
2		47	20 years.	Interstitial and sub-peritoneal multi-nodular growth filling abdomen to 4 inches above umbilicus.	General pressure symptoms and impairment of health.	Intra-uterine, 100 to 200 ma., eight times, daily.	Temporary aggravation of pain due to frequency of treatment subsequent improvement.	1 year.
3	Dr. H. A. Kelly, Baltimore.	49	5 years.	Submucous, sessile fibrocyst, enlarging uterus symmetrically to size of seventh month of pregnancy.	Bloody and watery discharge, pain, and general impairment of health.	Intra-uterine, — and +, 25 to 300 ma. every other day until os dilated and tumor presented.	Septicemia occurred during expulsion of tumor, followed by death on the twelfth day.	
4	Dr. T. Hewson Bradford, Philadelphia.	38	2 years.	Submucous sessile polyp of small size; uterus hypertrophied; cavity four inches.	Pain and purulent leucorrhea.	Intra-uterine, — and +, 40 to 150 ma.; ten applications.	Relief of symptoms; reduction of tumor to a nodule and of uterus to normal size.	

5	Dr. T. Hewson Bradford, Philadelphia.	38	2 years (?).	Intramural, multinodular growth, filling abdomen and extending two inches above navel.	Profuse and hastened periods, severe pain, and difficult locomotion.	Intra-uterine, + and —, 65 to 150 ma. at intervals of week or more.	Sympt. cure; patient reports disappearance.	8 years.
6	Dr. F. Woodbury, Philadelphia.	41	12 years.	Subperitoneal and intramural multinodular growth, extremely hard, filling pelvis and lower third of abdomen.	Constant pain, aggravated at periods, which were of 2-week type, and profuse, offensive, purulent leucorrhea.	Intra-uterine, 60 to 200 ma. — twice weekly. Later once weekly.	Patient reports disappearance. The discharge quickly cured.	16 years.
7	Dr. Bradford, Philadelphia.	34	9 mos.	Intramural growth filling pelvis, with subperitoneal projection reaching crest of the ilium.	Constant pain in left groin and on walking, with profuse, purulent leucorrhea.	Intra-uterine, —, 50 to 150 ma. twice a week.	Disappearance of tumor and of all symptoms, and reduction of uterus to normal size. Bands of adhesion left.	8 years.
8	Dr. William Pepper, Philadelphia.	40	1½ years.	Intramural symmetric fibroid of large size, wedged in pelvis and extending to the navel.	Severe pain, inflammatory attacks, pressure symptoms, and impairment of health.	Intra-uterine, 80 to 250 ma. — every other day. Later, every fourth day.	Quick release upward into abdomen, with improvement of health ; subsequent reduction to two inches below navel (one-third).	No further change after 15 years.
9	Dr. Bradford, Philadelphia.	42	1 year.	Intramural nodule, 2 inches in diameter, in posterior wall of retroflexed uterus.	Pain and other pressure symptoms, with menorrhagia and profuse purulent leucorrhea.	Intra-uterine, 50 to 125 ma. — twice weekly, with intervals of non-attendance.	Sympt. relief and considerable shrinkage.	3 mos.

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*continued*).

NO. OF CASE.	REFERRED BY OR TREATED AT	AGE OF PATIENT	KNOWN DURATION OF GROWTH.	DESCRIPTION OF GROWTH.	CLINICAL SYMPTOMS.	METHOD OF TREATMENT.	RESULTS.	TIME AFTER CESSATION OF TREATMENT WHEN RESULTS WERE VERIFIED.
10	Dr. Bradford, Philadelphia.	33	2 mos.	Interstitial growth, size of small orange, in retroverted uterus.	Flooding two weeks at last period, with constant pressure symptoms.	Intra-uterine, +, 25 to 100 ma. twice a week, with intervals of non-attendance.	Menstruation regular and normal, and sympt. cure. Patient shortly after died under operation which was forced on her against her wishes.	
11	Dr. Bradford, Philadelphia.	30	1 year.	Interstitial, size of fist, in right side of fundus; cervix elongated; syphilitic history.	Hemorrhages at periods, which are irregular and frequent; profuse leucorrhea and painful locomotion.	Intra-uterine, +, 35 to 100 ma. once a week, with intervals of non-attendance.	Menstruation regular and painless, relief of pain, and slight reduction in size.	
12		36	1 year.	Two subperitoneal pedunculated growths sizes of large orange and lemon, sepa. attach.	No symptoms.	Intra-uterine, 30 to 50.	No change.	3 mos.
13	Dr. William Goodell, Philadelphia.	48	6 years.	Submucous, size of large adult head, attached by broad base; os admitting two fingers. Growth rapid.	Continuous and dangerous hemorrhages, with pain and impairment of health.	Intra-uterine, + and —, 70 to 350 ma. every other day.	Arrest of bleeding and menstruation for three months, followed by discharge of a fibrous mass and complete disappearance of remainder.	15 years. Patient reports contin'd health in recent letter

14	Howard Hospital.	25	2 years.	Interstitial, size of large lemon, in anterior wall. Perimetric adhesions.	Irritable bladder, pain in back, and painful locomotion.	Intra-uterine, —, 35 to 50 ma. twice a week.	Relief of symptoms; no record of change of size.	
15	Howard Hospital.	40	3 years.	Interstitial growth, size of lemon, in posterior wall of retroflexed uterus, occupying Douglas's pouch.	Severe pain, pressure, profuse hemorrhage, and leucorrhea. Menstruates every 21 days.	Intra-uterine, +, 50 to 125 twice a week.	Arrest of hemorrhage, restoration of menses to 28-day type, and slight reduction in size.	1 month.
16	Dr. Bradford, Philadelphia.	28	3 years.	Interstitial growth filling pelvis. Uterus retroverted. Syphilitic history.	Hemorrhagic periods and constant pain.	Buried puncture, —, 200, three times, and intra-uterine, +, 50 to 100 once a week.	Relief of pain, regulation of menstruation, and considerable reduction in size.	6 mos.
17	Howard Hospital.	34	2 years.	Interstitial growth filling pelvis and extending above level of upper spines of ilium.	Profuse hemorrhage and impairment of health.	Intra-uterine, +, 60 to 110 ma. twice a week.	Total disappearance of tumor. Uterus normal in size. Menstruation normal. Hemorrhage arrested.	3 mos.
18	Howard Hospital.	23	Unknown.	Interstitial, size of an orange, in anterior wall.	Excessive menorrhalgia and anticipated periods. Very tender in hypogastrium.	Intra-uterine, + and —, 30 to 70 once a week.	No record. Case lost sight of.	

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*continued*).

No. of Case.	Referred By or Treated At	Age of Patient.	Known Duration of Growth.	Description of Growth.	Clinical Symptoms.	Method of Treatment.	Results.	Time After Cessation of Treatment When Results Were Verified.
19	Howard Hospital.	50	14 years.	Subperitoneal nodular, filling pelvis and abdomen and extending to ribs. Treatment confined to nodule in Douglas's pouch.	Pressure symptoms, affecting rectum and bladder especially.	Puncture, + and —, 50 to 100 ma., six times.	Nodule in pelvis smaller and flatter. Pressure symptoms lessened, and bowels move more freely.	
20	Howard Hospital.	30	6 years.	Interstitial enlargement of fundus to a size that fills pelvis. Multinuclear, firmly adherent. Cavity, 3½ inches.	Hemorrhagic periods 21-day type, with menorrhalgia and tenderness.	Intra-uterine, +, 60, followed by — vag., 40. The first treatment caused prolonged hemorrhage and pain.	No sign of tumor except lumps in tubal region. Uterus normal in size and movable. No pain. Periods regular.	6 mos.
21	Howard Hospital.	40	2 mos. (?).	Interstitial, globular, size of large cocoanut, in posterior wall. Cavity, 4 inches.	Constant hemorrhage and pain. Bladder irritable.	Intra-uterine, +, 30, four times.	Disappearance of pain.	
22	Howard Hospital.	40	1 year.	Interstitial, size of goose-egg, in left wall, extending above level of true pelvis.	Pain, fever, irritability of bladder, and irregular menstruation.	Intra-uterine, —, 30 to 60 ma.	Complete disappearance of projection and symptoms.	1½ mos.

23	Howard Hospital.	45	Unknown.	Interstitial, size of cocoa-nut, in anterior wall, extending to upper level of ilium. Cavity, 4½ inches.	Hemorrhage and pain.	Intra-uterine, +, 20 to 80 ma., six times.	Hemorrhage arrested by first application. Subsequent relief of pain. No record of change of size.	
24		41	2 years.	Intramural, growth posterior and to left. Whole mass size of goose-egg. Cavity, 3½ inches.	Immense loss of blood at periods of 21-day type. Pain and tenderness and profuse leucorrhea. General health impaired.	Intra-uterine, 15 to 100 ma., +, twice a week, later once a week.	Complete disappearance of growth, the cavity shrinking to 2½ inches. Periods normal, without flooding or pain.	8 years.
25	Howard Hospital.	36	14 years.	Interstitial growth in anterior wall, nearly filling pelvis. Cavity, 3½ inches.	Flooding at periods, with pain, tenderness, and leucorrhea.	Intra-uterine, +, 35 to 45, five times.	Flooding arrested and improvement of symptoms.	1½ years.
26	Howard Hospital.	33	2 years.	Interstitial involvement of whole uterus, including cervix, filling pelvis and extending to crest of iliac bones.	Flowing every day for two years; no tenderness and no adhesions.	Intra-uterine, +, 50 to 85 ma. once a week.	Hemorrhage ceased after first application.	
27	Howard Hospital.	40	2 mos. (?).	Intramural growth, size of goose-egg, in anterior wall.	Pain and bladder pressure, with much local tenderness. Menstruation irregular. Leucorrhea profuse.	Intra-uterine, + and —, 20 to 50 ma. twice a week.	Complete sympt. cure and reduction of tumor to the size of a walnut. It is now subperitoneal. Menses normal.	1 year.

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*continued*).

No. of Case.	Referred By or Treated At	Age of Patient.	Known Duration of Growth.	Description of Growth.	Clinical Symptoms.	Method of Treatment.	Results.	Time After Cessation of Treatment When Results Were Verified.
28	Dr. William Goodell, Philadelphia.	47	7 years.	Interstitial myoma extending an inch above navel, with a cystic projection on right containing "cells of Drysdale."	Attacks of intense pain at periods, in which tumor swells several times larger, impinging on ribs; no hemorrhage. Health impaired.	Intra-uterine, + and —, 40 to 150 twice weekly, changed to abdomino-dorsal alternatives, 150 ma., after 3 mos., with aspiration of cysts.	Reduction of solid part of tumor to size of orange; subsequent increase of cystic portion. Operation advised, under which patient succumbed.	
29	Dr. A. W. Watson, Philadelphia.	29	9 mos.	Intramural and subperitoneal projection from right cornu, reaching to 1½ inches below navel. Cavity, 3½ inches.	Menstrual flooding every 3 weeks, with constant pain and tenderness. Menorrhalgia.	Intra-uterine, +, 25 to 70 once a week, with intervals. Vaginal applications for a time.	Symptomatic improvement. Tumor slightly smaller and more disengaged. Later was operated on. Present health poor.	4 years.
30	Dr. Wharton Sinkler, Philadelphia.	44	12 years.	Interstitial enlargement of uterus, with projections to both sides. Electrode inserted 3½ inches.	Menstrual cramps requiring physician and morphia regularly. Flow lasts two weeks and is profuse.	Intra-uterine, +, 20 to 60 about twice a week. Cramps followed treatment.	Relief of pain and restoration of normal flow (5 days). Tumor distinctly smaller.	7 mos.
31		30	1 year.	Intramural growth, size of large lemon, in left wall.	Constant bleeding, lasting for months, requiring rest in bed; constant pain and tenderness; copious leucorrhea.	Intra-uterine, +, 20 to 30, six times, with one + vag. 100.	Relief of pain, hemorrhage, and leucorrhea. No notes of change in size.	

32	Dr. E. L. Duer, Philadelphia.	46	2 years.	Interstitial enlargement of uterus to size of child's head, extending to 3 inches below navel.	Former attacks of bleeding; at present pain and pressure symptoms.	Intra-uterine, — and +, 20 to 70 ma.; later intra-uterine alternatives, 70 to 100 ma. once a week.	Complete disappearance of tumor and cure of all symptoms.	11 years.
33	Dr. Lusk, Penn Yan, N. Y.	45	6 years.	Subperitoneal growth, filling pelvis and extending to 1¾ inches of navel, attached by sessile pedicle to fundus of uterus.	Pressure symptoms in moderate degree.	Vagino-abd. alternatives, 150 ma., with occasional intra-uterine, —, 30 to 100. Puncture impossible, owing to bladder.	Release of tumor from pelvis upward into abdomen. Results otherwise negative.	1 year.
34	Dr. William Goodell, Philadelphia.	45	4 years.	Interstitial multinodular growth, size adult head, extending to 2 inches below navel.	Bleeding periods and local tenderness associated with bronzed skin, anemia, and neurasthenia.	Vagino-abd. alternatives, 100 ma. once a week. Intra-uterine treatment not well borne.	Normal periods, great improvement in health, and slight reduction in size.	8 years.
35	Dr. T. C. Davis, Bridgeton, N. J.	50	Discovery recent.	Subperitoneal sessile growth, extending from Douglas's pouch to 2 inches below navel. Narrow, movable.	Retention of urine occurring frequently caused tumor to be discovered. Much pain in left leg. Menses free.	Buried puncture, —, 100 to 150 ma. every two weeks.	Complete disappearance of tumor and restoration of health.	10 years. Recent letter reports contin'd good health.
36		36	5 years.	Intramural projection size of walnut from posterior wall. Cavity 3½ inches. Enlarged ovary on right side.	Menorrhalgia and menorrhagia at 3-week intervals. Constant pain and weight. Leucorrhea.	Intra-uterine, +, 30 to 60 once a week, at intervals.	Normal periods, free from pain at 4-week intervals, with relief of weight symp. and reduction of cavity to 3 inches.	2 years.

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*continued*).

No. of Case.	Referred By or Treated At	Age of Patient.	Known Duration of Growth.	Description of Growth.	Clinical Symptoms.	Method of Treatment.	Results.	Time After Cessation of Treatment When Results Were Verified.
37		52	5 years.	Intra-uterine fibrous polyp, size hen's egg.	Exsanguinated by excessive and long continued hemorrhages.	Intra-uterine faradic to extrude tumor. After expulsion, removal by torsion. Base treated by + galv., 40.	Removal of tumor and restoration of health.	1 year.
38	Dr. G. H. Whitcomb, Greenwich, N. Y.	46	3 years.	Interstitial fibroid mass reaching to 1½ inches of navel, about size of adult head.	Attacks of severe pain; lameness and edema of right leg. Pain and local tenderness.	Intra-uterine, —, 125 following vaginal alternatives 80 to 125 twice a week.	Removal of lameness in 2 weeks. Later sympt. cure and complete disappearance of tumor.	11 years. Present health perfect.
39	Howard Hospital.	40	15 years.	Intramural fibroid size of large apple in posterior wall.	Tenderness and pressure on bladder. Old history of hemorrhages.	Intra-uterine, + and —, 30 to 80 once or twice a month.	Sympt. cure and considerable reduction in size.	6 mos.
40	Howard Hospital.	29	6 years.	Interstitial growth enlarging uterus to size of orange.	Pain and profuse periods, the latter recurring every 2 weeks.	Intra-uterine, +, 15 to 30 ma.	Arrest of hemorrhage and cure of symptoms. Great reduction in size.	6 mos.
41	Howard Hospital.	37	6 years.	Intramural growth in posterior wall, filling pelvis and extending 2 inches above symphysis.	Pain and profuse periods. Bladder much affected by pressure.	Buried puncture, —, 250 ma. six times, well borne. Intra-uterine badly borne.	Partial relief of pain by puncture and tumor reduced below symphysis. Abscess of ovary coincident and operated upon, with fatal results.	

42	Howard Hospital.	40	12 years.	Intramural and subperitoneal growth filling abdomen to 1½ inches above navel. Syphilitic suspicion.	Pain and profuse periods. Locomotion painful.	Buried puncture, —, 200 ma., and intra-uterine, +, 30 to 50 weekly, at intervals, later abdominal puncture 100 ma., —.	Relief of pain. Menstruation regular and less free. Patient reports that the tumor has disappeared.	8 years.
43	Howard Hospital.	29	5 years.	Interstitial size of sweet potato.	Pain, profuse and frequent periods. Was opened and operation abandoned three years ago.	Vag., +, 30 to 100 twice a week.	Symptomatic cure. No change in size.	6 mos.
44	Howard Hospital.	48	7 years.	Submucous growth enlarging uterus to fill pelvis and reaching to half inch of navel.	Bleeding profusely for several years. Now nearly exsanguinated. Much pain.	Intra-uterine, +, 60 ma.	Arrest of hemorrhage and later extrusion of tumor *per vaginam*.	4 years.
45	Dr. Philip Marvel, Atlantic City, N. J.	42	1 year.	Symmetrically enlarged uterus to size of orange. Os admits sound only.	Has been flooding almost constantly for a year, with much pain. Ergot ineffectual.	Intra-uterine, +, 40, followed by delivery of tumor size pullet's egg. Subsequent cauterization of base.	Anatomical and symptomatic cure.	5 years.
46		45	15 years.	Symmetric ovoid abdom. tumor size of ninth month of pregnancy 4½ inches above navel; semi-elastic. Circumference, 37 inches.	Hemorrhages and pain. Increase of size marked in past year.	Abdominal punct., —, 60 to 300 ma.	Complete disappearance of tumor and restoration of health.	8 years.

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*continued*).

NO. OF CASE.	REFERRED BY OR TREATED AT	AGE OF PATIENT.	KNOWN DURATION OF GROWTH.	DESCRIPTION OF GROWTH.	CLINICAL SYMPTOMS.	METHOD OF TREATMENT.	RESULTS.	TIME AFTER CESSATION OF TREATMENT WHEN RESULTS WERE VERIFIED.
47	Dr. William Goodell, Philadelphia.	27	6 years.	Symmetric ovoid abd. tumor size of adult head extending to 1 inch above navel.	Health prostrated from exhausting hemorrhages.	Intra-uterine, +, 50 to 250 ma.; later abdominal punct., 200 ma., —.	Arrest of hemorrhage and restoration of health. Anatomical change but slight at last report.	7 years.
48	Dr. A. W. Knox, Raleigh, N.C.	52	4 years.	Growth on anterior aspect of uterus extending to navel. Capacious cavity 4 inches deep.	Continuous bloody disch. for a year, with pain; two attacks of pelvic inflammation. Tenderness in left ovary.	Intra-uterine, +, 25 to 100 ma.	Symptomatic cure and reduction of tumor about one-half.	4 years.
49		41	3 years.	Interstitial growth of uterus size of orange, with projection to left, size of walnut.	Pain in ovarian regions for 11 years, aggravated by sitting posture. Severe menorrhalgia.	Intra-uterine, —, 30 to 60 ma., followed by sec. faradic for relief of pain.	Complete disappearance of growth and restoration of health.	11 years.
50		35	4 years.	3-lobed abdominal tumor, one reaching to ribs. Cavity, 5 inches.	Exsanguinated from excessive menstrual periods.	Intra-uterine, +, 50 to 100.	Cure of hemorrhage. No note of reduction of size.	Lost sight of.
51		33	10 years.	Large abdominal tumor extending 5 inches above navel, of soft consistence.	Was cured of hemorrhage previously by electricity under Dr. Drysdale. Now but little discomfort.	External applications, strong galv. and farad. currents.	Temporary reductions in size that were not permanent. Operation advised, which was successful.	

52	Dr. James Barton, Philadelphia.	43	8 years.	Immense abdominal tumor, 42½ inches around waist, filling abdomen and displacing bladder in front of pubes.	Severe hemorrhages, and weight and size causing great deformity. An operation had been attempted and abandoned.	Abdominal punct., —, 200 to 400 ma.	Symptomatic cure and slight reduction in size.	3 years.
53		46	7 years.	Multinodular abdominal tumor, highest point 2 inches above navel. Cavity, 5 inches.	Hemorrhages, attacks of pain, and constant tenderness.	Intra-uterine, +, 50 to 75 ma. ; flexible electrode.	Symptomatic cure and slight reduction in size, after limited treatment.	4 years.
54		35	3 years.	Interstitial growth of uterus to size of hen's egg.	Persistent menorrhagia.	Intra-uterine, +, 50 to 75 ma. Sectional carbon electrode.	Patient lost sight of.	
55	Dr. R. M. Slaughter, Theolog. Seminary, Va.	40	6 years.	Interstitial abdominal tumor, size of adult head ; upper limit 3 inches above navel. Cavity, 6 inches.	Frequent alarming hemorrhages and impaired health. Is growing larger.	Intra-uterine, +, 100 to 250 ma. Carbon electrode.	Cure of hemorrhages, reduction to 1 inch above navel, and restoration of health.	2 years.
56	Dr. William Goodell, Philadelphia.	45	3 years.	Interstitial pelvic tumor size of large orange. Cavity, 5 inches.	Exhausting hemorrhages and impairment of health.	Intra-uterine, +, 45 to 75. Rigid electrode.	Disappearance of tumor and restoration of health.	8 years.
57		35	4 years.	Multinodular abdominal tumor size of two fists. Cavity, 3½ inches, tortuous and narrow.	Profuse periods, hemorrhagic at times ; pain and tenderness.	Intra-uterine, +, and alternatives, 50 to 100 ma.	Symptomatic cure and some reduction in size.	

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*continued*).

NO. OF CASE.	REFERRED BY OR TREATED AT	AGE OF PATIENT.	KNOWN DURATION OF GROWTH.	DESCRIPTION OF GROWTH.	CLINICAL SYMPTOMS.	METHOD OF TREATMENT.	RESULTS.	TIME AFTER CESSATION OF TREATMENT WHEN RESULTS WERE VERIFIED.
58	Dr. Lawrence Wolff, Philadelphia.	40	3 years.	Interstitial and subperitoneal abdominal tumor extending 3 inches above navel. Cavity, 4 inches. Tortuous.	Menorrhalgia and tenderness with leucorrhea, but little pain.	Intra-uterine alt., 60 to 150 ma., followed by faradic.	Symptomatic cure and reduction to 1½ inches above navel.	5 years.
59	Howard Hospital.	40	2 years.	Interstitial abdominal tumor, extending to navel.	Hemorrhagic and tender, and has suppression of urine from pressure.	Intra-uterine, +, 60 to 75, and vag. appl. for short period.	Symptomatic cure; no note of reduction in size.	Lost sight of.
60	Dr. S. M. Ross, Altoona, Pa.	29	2 years.	Interstitial pelvic tumor size of lemon posterior to fundus.	Menorrhagia and pain, with feeling of weight.	Intra-uterine, +, 50 to 100 ma.	Symptomatic cure; no reliable information as to reduction.	
61	Drs. Hemminger and Bixler, Carlisle, Pa.	39	7 years.	Intra-uterine sessile fibroid, thoroughly cystic and vascular, size of seventh month of pregnancy. Os dilated.	Constant watery, at times bloody, discharge, and impairment of health.	Bipolar intra-uterine punctures, 400 to 700 ma.	Complete destruction of intra-uterine tumor and reduction of nodular uterus to size of a lemon.	8 years.
62		40	3 years.	Interstitial abdominal tumor size adult head, extending 3 inches above navel, with ascitic fluid in peritoneum.	Constant bleeding and shortness of breath on walking.	Intra-uterine, +, 50 to 60 for short time.	Reduction in flow to normal. No change in size. Subsequently removed by Dr. Kelly.	

63	Dr. S. S. Maynard, Frederick, Md.	50	13 years.	Interstitial pelvic tumor of fundus, the whole about the size of a fist.	Some pain and tenderness; had been greatly relieved by previous attendant under electricity.	Intra-uterine, —, 30 to 50 ma., and vag. galv.	Symptomatic cure, arrest of growth, and some reduction in size.	4 years
64	Dr. William Goodell, Philadelphia.	32	8 years.	Interstitial pelvic tumor of fundus about size of goose-egg.	Menorrhalgia and severe attacks of pain. Had been opened by a surgeon who desisted from removal.	Intra-uterine, —, 30 to 40; mainly vaginal on account of pain.	Improvement of symptoms.	
65	Dr. A. W. Knox, Raleigh, N. C.	34	1 year.	Multiple interstitial and subperitoneal tumor size of an orange.	Pain and pressure on bladder.	Intra-uterine, +, 40 to 80 ma.	Symptomatic cure and slight reduction in size.	
66	Dr. J. Chambers, Kingston, N. Y.	46	6 mos.	Interstitial pelvic tumor size of hen's egg, with peri-uterine tenderness. Cavity, 3½ inches.	Hemorrhagic periods; severe pain in ovarian regions. Just recovered from peritonitis.	+ vagino-abd. followed by intra-uterine, —, 30.	Symptomatic cure and distinct reduction in size.	3 years.
67	Dr. J. Reynolds, Potsdam, N. Y.	43	2 years.	Interstitial abdominal tumor of large size to ½ inch below navel. Cavity, 4 inches.	Growing rapidly and had become very uncomfortable.	Intra-uterine, —, 40 to 50.	Symptomatic cure and some reduction in size.	11 years.
68	Dr. T. C. Rich, Williamsport, Pa.	45	8 years.	Very large abdominal tumor, size of uterus at term.	Exsanguinated and cachectic from constant hemorrhages and recent attack of peritonitis. Temp. 101°.	Intra-uterine, +, 100 to 200 ma.; carbon electrode, alternating with vaginal galv.	Surprising restoration of health, following gradual cessation of hemorrhages; later diminution of size.	1 year.

Table of One Hundred and Ten Consecutive Cases of Fibromata Uteri Under Electric Treatment (*continued*).

No. of Case.	Referred By or Treated At	Age of Patient.	Known Duration of Growth.	Description of Growth.	Clinical Symptoms.	Method of Treatment.	Results.	Time After Cessation of Treatment When Results Were Verified.
69	Howard Hospital.	48	Unknown.	Abdominal tumor, interstitial, extending to 1 inch below navel. Cavity entered 3 inches.	No symptoms particularly pointing to tumor. Patient has lupus of skin.	Intra-uterine, +, 20 to 60 ma.	Reduction in size to 2½ inches below navel.	6 mos.
70		34	4 years.	Multinodular interstitial and subperitoneal tumor about size of fist.	Tenderness extreme, menstruation scanty.	Intra-uterine, —, 60 to 80 ma. Later, — vaginal puncture, 200 ma.	No continuous relief of tenderness, and tumor still growing.	4 years.
71		47	9 mos.	Interstitial pelvic tumor, size of fist.	Hemorrhages every 3 weeks for 3 years. Very profuse; now almost constant.	Intra-uterine, +, 50 to 100 ma.	Symptomatic cure and great reduction in size.	2½ years.
72	Dr. H. W. Elmer, Bridgeton, N. J.	54	4 years.	Multinodular pelvic tumor size of fist (suspicion of malignancy).	Constant hemorrhages for several years, with impairment of health.	Intra-uterine, +, 50 to 150 ma. Carbon electrodes; later zinc-amalgam cataphoresis 50 to 100 ma.	Arrest of hemorrhages and improvement of symptoms. Tumor probably smaller.	7 years.
73		46	5 years.	Interstitial abdominal tumor size of egg-plant, extending to 2½ inches of navel. Cavity, 4 inches.	Hemorrhages at periods and some impairment of health.	Intra-uterine, +, 40 to 100 ma.	Symptomatic cure and some reduction in size.	2 years.

74	Dr. F. H. Martin, Chicago, Ill.	30	6 years.	Interstitial pelvic tumor size of large fist.	Profuse periods. Tumor again growing after operation for tying broad ligaments. Adherent vag. sinus.	Intra-uterine, +, 25 to 60 ma.	Symptomatic improvement in pain and hemorrhage. Tumor smaller.	No advice since treatment.
75		38	3 years.	Interstitial pelvic tumor of fundus, size of pullet's egg. Cavity, 3 +, retroflexed.	Hemorrhagic periods. Lame in left leg from pressure. Health depressed.	Intra-uterine, +, 50 to 75, flexible cotton-covered electrode interspersed with vag. galv.	Disappearance of hemorrhages, limp, and other symptoms, and some reduction in size.	6 mos.
76	Howard Hospital.	52	Unknown.	Interstitial pelvic tumor of fundus about 2 inches in diameter, projecting into Douglas's pouch.	Occasional hemorrhages, some tenderness, and impairment of health.	Intra-uterine, +, 50, and vag. galv.	Disappearance of tumor and symptomatic cure.	1 year.
77	Dr. W. S. Janney, Philadelphia.	43	6 mos.	Interstitial abdominal tumor filling lower abdomen to 2 inches above navel.	Hemorrhagic periods, tenderness, and general impairment of health.	Intra-uterine, zinc-amalgam cataphoresis, 40 to 80 +.	Disappearance of tumor and restoration of health.	5 years.
78		26	Recent.	Interstitial pelvic tumor, size of cocoanut. Cavity, 4 inches.	Pain and menorrhagia.	Intra-uterine, +, 35, flexible electrode, on six occasions.	Symptomatic cure.	Lost sight of.
79	Dr. Thomas Drysdale, Philadelphia.	45	4 years.	Interstitial abdominal tumor size of adult head, filling lower half of abdomen to navel. Cavity, 6½ inches.	Frequent hemorrhages and menorrhagia, with pain, leucorrhea, and impaired health.	Intra-uterine, +, 200, sectional elect.; later zinc-amalgam cataphoresis.	Symptomatic cure and reduction to 2 inches below navel.	

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*continued*).

NO. OF CASE.	REFERRED BY OR TREATED AT	AGE OF PATIENT.	KNOWN DURATION OF GROWTH.	DESCRIPTION OF GROWTH.	CLINICAL SYMPTOMS.	METHOD OF TREATMENT.	RESULTS.	TIME AFTER CESSATION OF TREATMENT WHEN RESULTS WERE VERIFIED.
80	Dr. R. H. Hamill, Philadelphia.	40	5 years.	Multinodular abdominal tumor of large size, 2½ inches above navel.	Mens. twice a month with constant pain.	Intra-uterine, +, 100 on eight occasions.	Unknown. Tumor subsequently removed by Dr. Hamill.	
81	Howard Hospital.	27	1 year.	Symmetric abdominal tumor ½ inch above navel. Cavity very narrow.	Hemorrhagic periods and very profuse muco-purulent leucorrhea.	Intra-uterine, +, 30 to 150.	Symptomatic cure. No record of change in size.	
82	Howard Hospital.	35	Uncertain.	Large mass of firm texture and irregular shape posterior to uterus, apparently connected.	Several attacks of peritonitis and constant pain.	Vag., +, 50 to 150.	Symptomatic cure and much reduction in size.	1 year.
83	Howard Hospital.	37	10 years.	Very large abdominal tumor—waist, 36½ inches circumference—extending 13½ inches above pubes.	Hemorrhages and pressure symptoms.	Intra-uterine, +, 75 on several occasions.	Results unknown.	

84	Howard Hospital	40	1 year.	Large abdominal tumor extending $3^{1}/_{2}$ inches above navel.	Hemorrhage and pressure symptoms.	Intra-uterine, +, 30 to 150.	Results unknown.	
85	Howard Hospital.	34	2 years.	Interstitial pelvic tumor, size of cocoa-nut, firmly fixed.	Profuse hemorrhages, and attacks of peritonitis. Health impaired.	Intra-uterine, + 100; later zinc amalgam cataphoresis, 75.	Symtomatic improvement. No change in size.	
86	Howard Hospital.	48	2 years.	Multinodular abdominal tumo extending 1 inch above naval.	Cramp-like pain in abdomen.	Intra-uterine, +, 125 ma.; flexible electrode.	Symptomatic cure and reduction of tumor to 1 inch below navel.	6 years.
87	Dr. J. F. Williams, of Chicago.	34	6 mos.	Interstitial fibroid size of hen's egg in fundus; old pelvic peritonitis.	Pain and interference with bladder.	Intra-uterine, —, 30 to 50 ma.	Restoration of health and some reduction in size.	
88		62	10 years.	Interstitial growth size of cocoa-nut.	Slight pressure symptoms only; passed menopause.	Vag. alternatives and abdomino-dorsal combined currents.	Improvement of general health and slight reduction in size.	2 years.
89	Dr. W. H. Bennett, Philadelphia.	42	3 years.	Interstitial growth size of child's head.	Difficulty in walking and general depression of health.	Intra-uterine, —, 125 to 300 ma.	Probably slight increase in size. Health better.	

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*continued*).

No. of Case.	Referred By or Treated At	Age of Patient.	Known Duration of Growth.	Description of Growth.	Clinical Symptoms.	Method of Treatment.	Results.	Time After Cessation of Treatment When Results Were Verified.
90		41	1 year.	Interstitial growth in fundus size of hen's egg.	Hemorrhages and general nervous breakdown.	Intra-uterine, +, 50 to 125 ma.		
91	Dr. Walter Ziegler, Philadelphia.	53	1 year.	Interstitial growth size of pregnant uterus at 5 mos.	Hemorrhages and pain.	Intra-uterine zinc-mercury, 50 to 160 ma.	Symptomatic cure. No change in size.	6 years.
92		38	3 years.	Interstitial growth filling pelvis and extending into abdomen to superior spines of ilium.	General health broken; pale, profuse menstruation.	Intra-uterine zinc-mercury, 60 to 75 ma.	Patient states that tumor has disappeared, and that her health is good.	4 years.
93		50	18 years.	Large multinodular growth larger than adult head, extending 5 in. above navel; cavity, 4 inches.	Profuse and frequent menstruation and general breakdown of health.	Intra-uterine zinc-mercury, 75 to 125 ma.		

94		48	4 years.	Large interstitial fibroid, size of cocoa-nut, filling pelvis and extending above brim of latter. Cavity, $5^{1}/_{4}$ in. deep and capacious.	Dangerous and prostrating hemorrhages, or else extreme pain at periods.	Zinc-mercury cataphoresis, 175 to 250 ma.	Hemorrhage and pain cured. No record of change in size.	5 years.
95		40	7 years.	Subperitoneal projection at left horn of uterus about size of large fist. Cavity, $3^{3}/_{4}$ inches.	Pain and general depression of health.	Zinc-mercury cataphoresis, 150 to 200 ma.	Symptomatic cure and restoration of health, and slight diminution of size.	4 years.
96		37	5 years.	Interstitial growth size of cocoa-nut filling pelvis and extending into abdomen. Cavity, $5^{1}/_{4}$ inches.	Continuous pain in left ovarian region and general depression of health.	Negative intra-uterine cotton-covered electrode 75 to 100 ma. Treatment prolonged owing to ovarian tenderness	Symptomatic cure and considerable reduction in size.	3 years.
97	Dr. W. H. Warder, Philadelphia.	42	2 years.	Interstitial growth size of adult head. Cavity, $4^{1}/_{2}$ in.	Constant hemorrhagic flow. Thyroid tablets useless.	Brass and zinc-mercury electrodes, 150 to 200 ma.	Symptomatic cure, disappearance of hemorrhages, and great reduction in size.	2 years.
98	Dr. Newbaker, Danville, Pa.	34	1 year.	Small subperitoneal bud, size of button, projecting from fundus.	Subjective symptoms moderate.	Intra-uterine negative 75 ma. and three buried punctures, 35-50 and 75 ma.	Patient was dissatisfied with results and submitted to an operation, during which she died.	

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*continued*).

No. of Case.	Referred By or Treated At	Age of Patient.	Known Duration of Growth.	Description of Growth.	Clinical Symptoms.	Method of Treatment.	Results.	Time After Cessation of Treatment When Results Were Verified.
99	Dr. Grumhein, Lebanon, Pa.	35	2 years.	Large, quickly growing tumor in right wall of uterus, size of adult head. Cavity, 5 in., capacious.	Hemorrhages and painful periods.	Zinc-mercury, 100 to 175 ma.	Decided reduction immediately after treatment.	Patient lost sight of.
100	Dr. David Jones, London, Eng.	49	12 years.	Two subperitoneal tumors size of hen's egg.	Profuse periods and mechanical interference with bladder and rectum.	Vaginal alternatives, 50 ma., and induction currents.	Symptomatic cure and reduction of growths to $^1/_2$.	2 years.
101	Dr. L. Wolff, Philadelphia.	34	3 years.	Interstitial growth about size of lemon, with inflamed appendages.	Constant pain in left ovarian region.	Vaginal and intra-uterine mercuric cataphoresis; latter in strength of 40 to 50 ma.	Symptomatic relief.	Still under treatment.
102		32	7 years.	Fibroid polyps associated with hypertrophied uterus.	Backache and pain in pelvis. Curettage failed to relieve.	Copper - mercuric cataphoresis, 50 to 70 ma.	Symptomatic cure and reduction to normal size.	1 year.
103		32	5 years.	Subperitoneal fibroids (two), size of hen's egg and large orange.	Pain and pressure symptoms.	Intra-uterine negative, 75 to 100 ma.	Tumor still growing. Relief of symptoms.	1 year.

104	Dr. Ferciot, Canton, O.	40	8 years.	Large interstitial growth reaching to $^1/_2$ in. below umbilicus.	Pressure symptoms.	Intra-uterine alternatives, 125 to 200 ma.	Tumor flatter, and all symptoms relieved. General health good.	2 years.
105	Dr. C. Eugene Riggs, St. Paul, Minn.	41	2 years.	Multinodular gr'th in posterior *cul-de-sac*, size of grape-fruit, fixed, with tenderness on left.	Pain, backache, and general depression of health.	Intra-uterine negative, 90 to 140 ma.	Symptomatic cure and reduction in size.	2 years.
106		32	Not noted	Large interstitial growth extending to 5 cm. below umbilicus, and about size of adult head.	Profuse hemorrhage, pain, and general depression of health.	Zinc-mercury cataphoresis, 125 to 175 ma.	No change.	1 year.
107		38	2 years.	Interstitial growth size of walnut. Had fibroid polyp removed two years ago.	Hemorrhages and pain.	Copper-merc'y cataphoresis, 50 to 180 ma.	Symptomatic cure and some reduction in size.	1 year.
108	Dr. B. F. Baer, Philadelphia.	43	7 years	Multinodular gr'th size of fist. Cavity, $3^1/_2$ in.; fixed.	Pressure symptoms and general depression of health.	Copper-merc'y cataphoresis, 60 to 75 ma.	Improvement in symptoms.	Still under treatment.

TABLE OF ONE HUNDRED AND TEN CONSECUTIVE CASES OF FIBROMATA UTERI UNDER ELECTRIC TREATMENT (*concluded*).

NO. OF CASE.	REFERRED BY OR TREATED AT	AGE OF PATIENT.	KNOWN DURATION OF GROWTH.	DESCRIPTION OF GROWTH.	CLINICAL SYMPTOMS.	METHOD OF TREATMENT.	RESULTS.	TIME AFTER CESSATION OF TREATMENT WHEN RESULTS WERE VERIFIED.
109	Dr. Pond, Alameda, Cal.	39	6 mos.	Interstitial growth size of orange in anterior wall, uterus anteflexed and fixed.	Hemorrhagic periods, with great depression of health and pains in back.	Copper-merc'y cataphoresis, 50 ma., and vaginal applications.	Improvement in symptoms.	1 year.
110	Dr. R. C. Olin, Detroit, Mich.	52	Not noted.	Large interstitial growth size of child's head, globular in form; upper limit, $^1/_2$ in. above umbilicus.	Profuse and exhausting hemorrhages at each period, with but little intermission.	Zinc- and gold-mercury cataphoresis, 110 to 160-ma.	No hemorrhage for a year; improved health. No cha'ge in size.	Under treatment.

For an analysis of this table see page 166.

INDEX.

Abdominal puncture, 162
  walls, relaxation of, 270
Abdomino-dorsal applications, 66
Abortion, electricity in, 288
Acid batteries, 347
Adams, Prof. W. G., on current diffusion, 40
Adenoids of rectum, 306
Alterative action of electricity, 61
Alternating currents, 328-392
  current step-down transformer, 26
Amenorrhea, 96
Ampère, the, 321
Anal fissure, 303
Anaphoresis (diffusion of ions from cathode), 56
Anelectrotonus (physiologic sedation at anode), 59
Anion (electro-positive radicle of molecule), 47
Anode (positive pole), 33
Ano-rectal cancer, 245
Apostoli clay pad, 348
  diagnostic test, 138
  intra-uterine electrode, 71
  on treatment of chronic metritis, 120
  treatment, 112
    results, 165
    special methods, 159
  work of, 31
Applications, abdomino-dorsal, 66
  spinal, 66
Applying mechanism, 344
Areolar hyperplasia of breast, 202
Arrangement of cells, 323
    in permanent battery, 341
Arrhemias on electrolysis, 46
  on the properties of ions, 48
d'Arsonval, 390
  currents, 373
Aseptic precautions in electro-gynecology, 30
Aspiration as a means of diagnosis, 29
Aspirator, 29
Atony of bladder, 293
Atrophic metritis, 125
Axillary cancer, 225

Bactericidal action of electricity, 60
Baird, W. T., 289
Batteries, acid, 347
  portable, 344
Battery solution, 347
Beck, Carl, 409
Benign diseases of the rectum, 303
  tumors of the breast, 202
Betz static machine, 375
Bicycle, its use by girls, 3
Bimanual abdominal palpation, 14
  pelvic examination, 19
Bipolar cataphoresis, 228
  intra-uterine electrode, 77
  vaginal applications, 69
    electrode, 70
Bivalve speculum, 17
Bladder, atony of, 293
  examination of, 294
Border-line between neurology and gynecology, 84
Bow-string interrupter, 366
Brothers, A., 282

Cabinet apparatus, 338
Calcium chloride as dryer, 378, 395

Campbell, H. F., 79
Cancer electrode, 219
  major applications, 209
  Massey method, 225
  minor applications, 240
  of axilla, 225
  of the body of uterus, 244
  of the breast, 225
  of the cervix, 239
  of the rectum, 245
  radiotherapy in, 205
Cataphoresis (propulsion of cations from anode), 52
  in cancer of breast, 225
    rectum, 245
    uterus, 239
Cataphoric sterilization in cancer, 205
Catarrhal affections of utero-tubal tract, 110
Catelectrotonus (physiologic stimulation at cathode), 59
Cathode (negative pole), 33
Cation (electro-negative radicle of molecule), 47
Carbon cylinder cell, 342
Caruncle, urethral, 292
Cell current, 362
Cells, dry, 344
    Columbia, 347
Celluloid, inflammability of, 379
Cervical endometritis, 113
Cervix, laceration of, 123
Chemic effects at each pole, 48
Chloride of calcium as dryer, 378, 395
Choice between electricity and the knife, 36
  of poles in gynecology, 62
Chronic metritis, 117
  ovaritis, 138
Clay pads, 348
Clothing and catching cold, 5
Cohnheim's hypothesis, 146
Columbia dry cells, 212, 345
Combined currents, 367
Concentrated and diffuse currents, 354
Connubial excess, 6
Constant current brush, 352
Constant current experiments, 351
  currents, 315, 328
Contra-indications to intra-uterine applications, 77
Controller, current, 331
Control of constant currents, 328
Care of magnetic battery, 362
Corporeal endometritis, 116
Correlation of natural forces, 45
Cosmetic applications of electricity, 307
Coulomb, the, 322
Crookes tube, 404
Cullen, T. S., 239
Current combiner, 368
Concentration within the body, 42
  constant, 315
  controller, 331
  curves, current, 388
  diffusion within body, 40
  from the mains, 328
  variation, 356
Cutter, Ephraim, 152
Cystic tumors of breast, 203
Cystoscopy, 294

Damon method, 164
Dehydration of static case, 378
Dermatitis, x-ray, 435
Developmental faults of womanhood, 1
Development of radiographic plates, 401, 421
Diagnostic test, Apostoli's, 138
  value of uterine discharges, 112
Differential diagnosis, hysteria and neurasthenia, 88
Direct current, 315, 328
    mains, utilization of, 209
  sparks, 381
Dispersing electrode, 215, 347
Displacement of pelvic viscera, 260
Dolbear, Prof. A. E., 32
Dorsal position, 13
Dosage of induction currents, 371
Dry cell battery, author's portable, 210
Dry cells, 343

Dudley, A. Palmer, 280
Dysmenorrhea (menorrhalgia), 98

Ectopic gestation, 277
Electricity in obstetrics, 277
Electrode (point of entrance of current into electrolyte), 33
  Apostoli bipolar intra-uterine, 77
    intra-uterine, 71
    tunneled rectal, 219
  bipolar vaginal, 70
  coverings, 38, 352
  dispersing, 215, 347
  galvano-puncture, 217
  hollow, bulbous, gold, 218
  Massey intra-uterine, 72
  vaginal, 68
  zinc-mercury, intra-uterine, 74
    cancer, 219
Electrode for induction currents, 371
Electro-gynecology, special value of, 34
Electrolysis, 45
Electrolytic interrupter, 399
Electromotive force, 315
Electrostatic capacity, 379
Electrothermic hemostasis, 239
Electrotonus (physiologic action of constant current on nerves), 59
Endometritis, 113
  cervical, 113
  corporeal, 116
Engelmann coils, 366
Epilation, 307
  needle, 308
Erosion of cervix, 114
Examination of patients, 9
  of the pelvis, 16
Extra-uterine pregnancy, 277

"Faradic" current, 358
Faults in circuit, 356
Ferguson speculum, 18
Fibroid tumors, 146
    classification of, 148
    contra-indications of electricity in, 159
Fibroid tumors, mode of action of electricity in, 156
    origin of, 146
    prognosis, 152
    selection of cases, 158
Fissure of anus, 303
Flemming induction battery, 362
Fluoroscope, 400
Fluoroscopy, 411
Foreign bodies, skiagraph, 419
Fox, George H., 307
Functional stimulation and sedation, 58
Fuse, 329

Gaiffe pocket induction battery, 289
"Galvanic" (constant) current, 315,
Gaston, J. McFadden, 208
Goelet bipolar vaginal electrode, 70
  coils, 366
Gold puncture electrodes, 217
Glass specula, 18
Goodell speculum, 17
Grad, Herman, 394
Granger, Amédée, 208, 237
Granular erosion of cervix, 114
Graphite controller, 333
Ground connections, 378

Hardaway, W. A., 307
Hard tube, 408
Haultain, F. W. N., 193
Hayes, Plym. S., 307
Hedley, W. S., 332, 335
Hematosalpinx, 136
Hemorrhagic metritis, 123
Hemorrhage, postpartum, 290
Hemorrhoidal needle, 304
Hemorrhoids, 303
Herdman, W. J., 345
High frequency currents, 383
  potential currents, 383
  tube, 406
Holtz machine, 376
Hydrosalpinx, 136
Hydrothermal applications, 80
Hyperemesis gravidarum, 288
Hyperplasia of uterus, 123

- Hysteria, 88

- Illumination of the vagina, 23
- Impotence and sterility, 274
- Incandescent circuit, 328
- Indifferent electrodes, 347
- Indirect sparks, 380
- Induction battery, diagram of, 359
  - current in labor, 289
    - stimulation, 66
- Inglis-Parsons, 208
- Inertia uteri, electricity in, 290
- Institutional treatment, 312
- Insulation, static, 379
- Internal resistance, 322
- Interpolar region, 45
- Interpretation of x-ray plates, 423
- Interrupter, 366
  - for Roentgen ray coil, 399
- Intra-uterine applications, 70, 71, 78
- Ions (atoms with electric charges), 47

- Jacketed pan for clay pads, 348
- Jackson, Herbert, 411
- Jenks, W. J., 358, 373
- Jewell controller, 332

- Keith, Thomas, 154
- Kellogg, J. H., 387
- Kennelly sinusoidal machine, 391
- Kidder high-tension battery, 364
- Knee-chest position, 79

- Labor, induction current in, 289
- Laceration of cervix uteri, 6, 123
- Leclanche cell, 343
- Leyden jars, 379
- Limitations of electricity as a remedy, 36
- Location of faults in circuit, 356
- Low tube, 406

- Magnetic induction currents, 358
- Mammary cancer, 225
  - gland, benign tumors of, 202
    - cystic disease of, 203
- Massage, 82
  - of abdomen, 272
- Massey abdominal puncture needle, 164
  - cancer electrodes, 219
  - controller, 333
  - hemorrhoidal needle, 304
  - miniature lamp, 24
  - portable dry-cell battery, 346
  - pelvic transilluminator, 28
  - rigid platinum electrode, 72
  - spinal elastic platinum electrode, 73
  - treatment of cancer, 205
  - tunneled rectal electrode, 219
  - vaginal electrode, 68
  - wall cabinet, 339
  - wired-cotton pads, 349
  - zinc-mercury cancer electrodes, 219
    - intra-uterine electrodes, 74
- McIntosh induction battery, 363
  - sinusoidal apparatus, 390
- Medicamental phoresis, 56
- Menorrhagia, 107
- Menorrhalgia, 98
  - nervous, 101
  - uterine, 102
- Menorrhspasm, 99
- Menstrual derangements, 96
  - pain, 98
- Menstruation, scanty, 97
- Mensuration of tumors, 14
- Mercuric cataphoresis, 55
- Meter, milliampère, 337
- Metritis, atrophic, 125
  - chronic, 117
  - hemorrhagic, 123
  - senile, 125
- Metrorrhagia, 107
- Metrosalpingitis, 126
- Megrowitz volt controller, 24
- Milliammeter, 337
- Milliampère, the, 322
- Miniature diagnostic lamp, 24
- Minor applications in cancer, 222
- Monopolar vaginal applications, 69
- Morton, W. J., 373
  - wave current, 382
- Motor for static machine, 378
  - nerve responses, 59

Moles, 310
Mucous membrane resistance, 355

Nævus pigmentosus, 311
  vasculosus, 310
Needle for epilation, 308
Nerve irritability, 356
Nervous menorrhalgia, 101
  prostration, 91
Neurasthenia, 91
  static treatment in, 95
Neuroses of urethra, 293
  vulva, 293
Normal formula of nerve response, 59
Nunn, R. J., 289

Ohm, the, 320
  law of, 321
Operative reimplantation of cancer, 239
Osteoscope, 409
Ovarian congestion, 142
  menorrhalgia, 106
Ovaritis, chronic, 138
Ozone administration, 384

Palpation of the abdomen, 13
Parallel arrangement of cells, 324
Pelvic affections, general causation, 5
  peritonitis, 137
  transilluminator, 28
Pessaries, 82
Phoresis (electro-chemical propulsion), 51
Physiologic basis of electro-therapeutics, 32
Pigmented nævus, 311
Plate holder in radiography, 403
Plates for radiographs, 401
Pocket battery for diagnostic lamp, 28
Polarity of an induction current, 368
  of static currents, 384
  test, 351
Polarization (accumulation of opposite charges about an electrode), 59
Polar regions, 43
Pole changer, 330
Portable batteries, 344
  for diagnostic lamp, 27, 28
Port wine mark, 310
Postoperative sequels, 144
Postpartum hemorrhage, 290
Postpuerperal metritis, 122
Posture in pelvic affections, 79
Primary coil, 362
  current, 364
Purulent salpingitis, 129
Pyosalpinx, 129

Radiographic plate, 401
Radiography, 394, 414
Radiotherapy, 429
Rectal cancer, 245
  electrode, tunneled, 219
  touch, 21
Rectum, adenoids of, 306
  benign tumors of, 303
  stricture of, 305
  ulcerations of, 306
Reed, Boardman, 272
Reflex neuroses of pelvic origin, 85
Relaxation of abdominal walls, 270
Resistance, 319
Rest cure, author's modification of, 95
  in hysteria, 88
"Rheostats," 333
Rheotome, 366
Rockwell's high-tension battery, 364
Roentgen, Conrad, 410
  ray coil, 398
    interrupter, 399
    stand, 403
    tube, 404
  rays, 394
Ruby lamp, 404
Rudiments of medical electricity, 315

Salpingitis, purulent, 129
Salt water on electrodes, 353
Scanty menstruation, 97
Secondary coil, 365
  current, 365
Senile metritis, 125

Series arrangement of cells, 323
  lamp, 334
Sheldon, Prof. Samuel, 373
Shunt controller, 336
  lamp, 334
Sigmoid flexure, diseases of, 303
Simpson sound, 20
Sims's position, 21
  speculum, 22
Singing rheotome, 366
Sinusoidal current, 387
Skiagraphy, 394, 414
Skiameter, 409
Skin residence, 355
Slocum, Harris A., 294
Smith, Lapthorn, 185
Snow, William Benham, 373
Soft tube, 408
Solution for acid batteries, 347
Specific resistance, 320
Speculum, bivalve, 17
  cylindric, 18
  Goodell, 17
  Sims's, 22
Spinal applications, 66
Stand for x-ray tube, 403
Static charge, 379
  electricity, 373
  electrodes, 385
  induced current, 383
  insulation, 379
  sparks, 381
  spray, 380
Stationary battery, 342
Step-down transformer, 26
Sterility and impotence, 274
Street main currents, 328
Stricture of rectum, 305
  of urethra, 292
Subinvolution, 122
  recent, 291
Superfluous hair, 307
Switchboard wiring, 330
    for both currents, 340
    for cells, 341

Table of resistances of wire, 320
  of specific resistances, 321
Tampons, 81
Temperature effects of current, 57
Toepler-Holtz machine, 376
Test for current, 351
  for faults in circuit, 357
  for polarity, 351
    of street current, 329
Tight lacing as cause of disease, 3
Transformation of alternating currents, 393
Transillumination of pelvis, 26
Tray for radiography, 404
Tripier, A., 31
  method in displacements, 266
Tubular speculum, 18
Tumors of breast, benign, 202
Tunneled rectal electrode, 219

Ulcerations of rectum, 306
Units of current, 321
Universal therapeutic controller, 333
Unslacked lime as a dryer, 396
Urethra, neuroses of, 293
  stricture of, 292
  ulcerations of, 292
Urethral caruncle, 292
Uterine discharges, diagnostic value, 112
  hyperplasia, 123
  menorrhalgia, 102
  sound, 20

Vacuum tube currents, 384
Vaginal constant current applications, 67
  douche, 80
  electrode, 68
  induction applications, 69
  puncture, 160
  specula, 17
  swabbing, 81
Vagino-abdominal applications in fibroids, 165
Van Houten & Ten Broeck static machine, 396
Vant Hoff on electrolysis, 46
Vetter current tap, 331
Voltage, measurement of, 338

Volt, the, 318
  control, 336
Volume of current, 321
Vulva, neuroses of, 293

Waist constriction, 3
Waite & Bartlett static machine, 377
Wall plates, 338
Warts, 310
Water cooling tubes, 408
de Watteville current combiner, 368
Wave current, Morton, 382
Wehnelt interrupter, 399
Westinghouse currents, 328
Weston meter, 337
Wet cells, 342
Wimshurst charger, 376
Wired cotton pads, 349
Wire "rheostats," 333
X-ray coil, 397
  dermatitis, 435
  plates, 401
  tube, 404

Zinc-mercury cancer electrodes, 219
  intra-uterine electrodes, 74

LANE MEDICAL LIBRARY

To avoid fine, this book should be returned on
or before the date last stamped below.

N227 Massey, G.B. 65365
M41 Conservative gynecolgy
1905 and electro-therapeutic

NAME	DATE DUE